

SECTION III
WETLANDS
AND
SURFACE WATER

January 1994

Prepared By :

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SECTION III - WETLANDS AND SURFACE WATER

3.1 WETLANDS

3.1.1 WETLANDS DETERMINATION

A wetlands determination for the facility was conducted in May 1993 by Espey, Huston & Associates (EH&A) of Houston, Texas. The wetlands report is included as Appendix 3-A and contains the following summary:

"No areas on the 43 acre tract were identified as wetlands. Of the three criteria required for wetland identification, only one sample site (SS2) exhibited only hydric soil indicators. But SS2 had neither a dominance of wetland vegetation, nor field indicators of wetland hydrology. Soil saturation at each of the sample sites, as noted on the data sheets, was thought to be attributed to recent heavy rains in the area. Because the boundary of the 43-acre tract was cleared and easily accessible, a cursory look was made to the adjacent forest. Although no sample points were established outside the boundary, no observable indicators of wetlands or jurisdictional areas were noted. Terrain and vegetation appeared similar to the subject tract. The prevalence of nonwetlands could be attributed to the steep topography and sandy soils which facilitated development of the natural drainage patterns in the hilly terrain."

3.1.2 ACOE JURISDICTIONAL DETERMINATION

A copy of the wetlands delineation report was submitted to the Army Corps of Engineers (ACOE), Vicksburg District, for review. Exhibit 3-1 contains the ACOE jurisdictional determination which concurs with the conclusions of the EH&A report. However, the response does note that "other regulated waters of the United States" are in the area. These waters are restricted to the intermittent, bank-contained streams that drain the property.

A permit for filling less than one acre of these areas was issued under the Nationwide Permit program subject to stated conditions and provided that the facility submit a

Louisiana Water Quality Certification. Water Quality Certification (WQC 930715-02) was received from the Louisiana Department of Environmental Quality, Office of Water Resources in October 1993 and was subsequently transferred to the ACOE (Exhibit 3-2).

Since the wetlands determination demonstrated the absence of wetland areas at the facility, the screening assessment will focus on storm water runoff to the nearest designated stream, Summerfield Branch. Figure 3-1 is a section of the National Wetlands Inventory Map for the Colfax vicinity and depicts the wetlands area nearest the facility as delineated through aerial photography. This area is designated as PFO1A, Palustrine-Broad Leaved Deciduous Forest and Temporary.

A small section of the facility roads and five storage magazines located on the southeastern portion of the facility drain toward this area. However, the treatment area, preparation building and the remaining storage magazines are located in areas that drain away from this wetland toward the north and west.

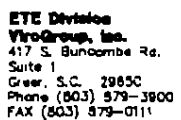
3.2 SURFACE WATER

3.2.1 SITE CHARACTERIZATION

3.2.1.1 Surface Drainage Characteristics

The majority of the facility is located in steep topography with 5-30% slopes and natural, intermittent drainage features. Much of the facility and adjoining property contains pine and hardwood trees. As shown in Figure 3-2, the operations area lies adjacent to the highest topographic point of the entire tract with three primary drainage features carrying surface water flow from the storage and treatment unit locations.

Discharge from the thermal treatment area retention pond drains north toward an intermittent stream that flows northwest. Drainage from other intermittent streams joins this flow to form Summerfield Branch approximately 6/10 miles west of Highway 471.



PROJECT NO.
16-30912

A second drainage channel drains the western corner of the facility. Runoff within this channel drains into an intermittent stream that eventually enters Summerfield Branch west of Highway 471. The wetlands report notes the presence of these intermittent streams and estimates their flow to be less than 5 cfs when full.

As noted in Section 3.1.2, surface runoff from the southeastern portion of the facility is channeled to an intermittent stream that flows into the designated wetlands area near the property boundary. This runoff does not contact any waste material and represents natural surface drainage.

The nearest water bodies receiving surface drainage from the facility and their approximate distance from the operations area boundary are as follows:

Summerfield Branch (NNW)	0.5	Mi.
Bayou Grappe (SSW)	2.0	Mi.

As shown on the topographic map in Section I, Figure 1-2, Summerfield Branch flows toward the northwest into Bayou Grappe. Bayou Grappe meanders from the northwest to the southeast where it splits into several bayous that eventually empty into the Red River.

Summerfield Branch, Bayou Grappe and the unnamed intermittent streams, which lie within the Red River Basin, are not listed in the Louisiana Administrative Code, Title 33-Environmental Quality, Part IX-Water Quality Regulations, Chapter 11. Chapter 11 lists water bodies that have designated uses and for which water quality criteria determinations have been made. The Red River is the major surface water body near the facility with water use criteria as listed in the regulations. Red River is also listed in the USGS Water-Data Report LA-92-1 for 1992, which contains water quality data for a Red River station located near Alexandria. No stream data is available in this report for Summerfield Branch

or Bayou Grappe.

3.2.1.2 100-Year Floodplain

The 100-Year Floodplain limits for the geographic area containing the treatment facility are indicated on the copy of the FEMA map that is included as Figure 3-3. The FEMA map that includes the site is Community No. 220076A, Panel 23 and Panel 24, Flood Hazard Boundary Map dated June 17, 1977. As indicated on the FEMA map, the facility is outside of the 100-Year Floodplain limits.

3.2.1.3 NPDES Storm Water Permit

R & D Fabricating and Manufacturing, Inc., former owner of the facility, was covered under an NPDES General Permit for Storm Water Discharge. A Notice of Termination has been filed to remove R & D from the permit and a Notice of Intent has been filed to include Laidlaw Environmental Services (Thermal Treatment), Inc. under the General Permit (Exhibit 3-3). LESI will conduct storm water sampling for the retention pond discharge after the new treatment units are in operation. During operation of the units, routine monitoring of the storm water will be conducted as required.

Table 3-1 contains storm water analytical data for the existing burners and includes organics, metals and indicator parameters. Concentrations for all parameters are indicative of background and show no apparent discharge of contaminants to the environment via storm water runoff.

3.2.1.4 Precipitation Data

Appendix 3-B contains precipitation data for the Alexandria, Louisiana vicinity obtained from the National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center's (NCDC's) Climate Services Branch and Louisiana State University, Department of Geography and Anthropology. Data provided includes: (1) Monthly

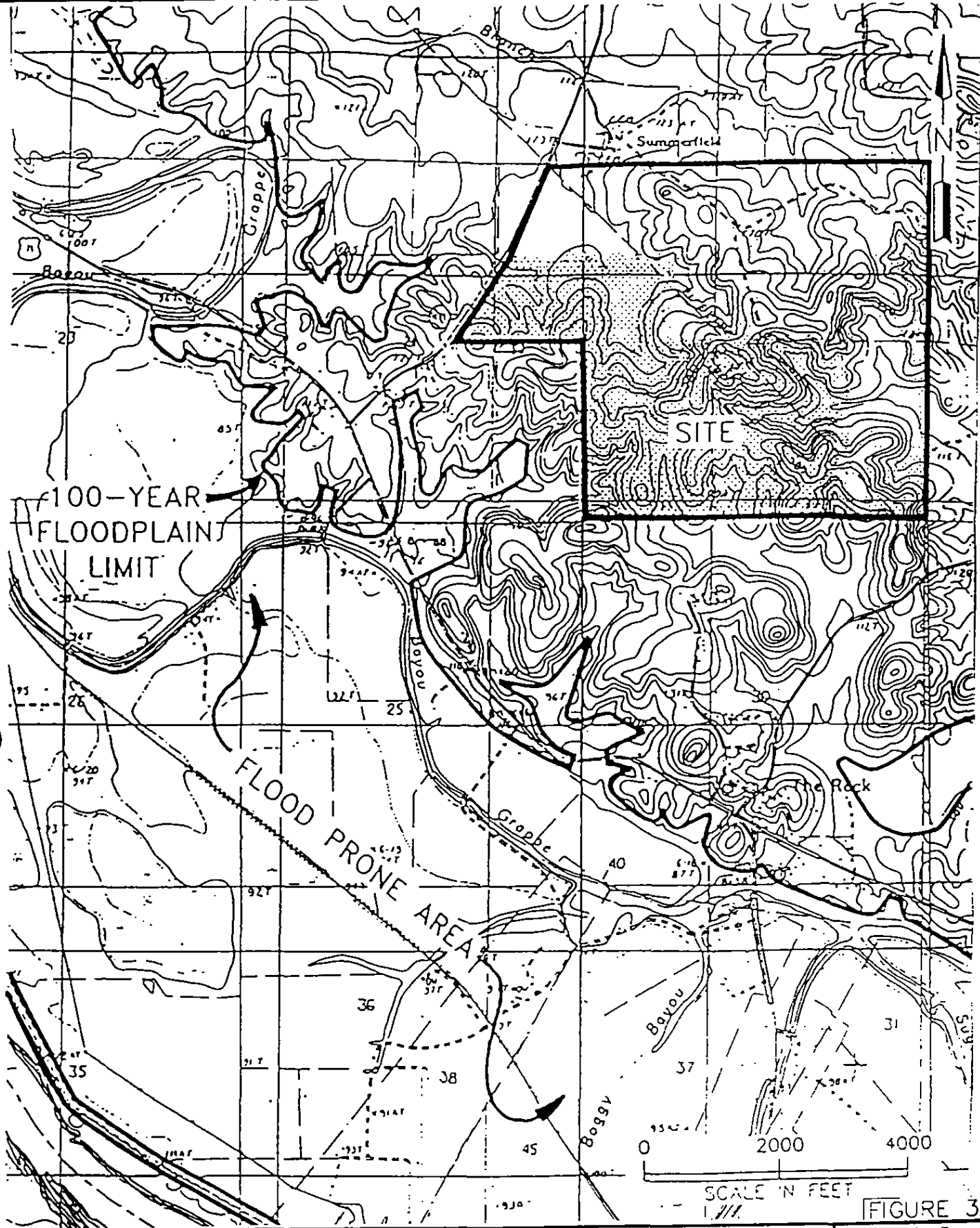


FIGURE 3-3



ETE Division
ViroGroup, Inc.
417 S. Buncombe Rd.
Suite 1
Greer, S.C. 29650
Phone: (803) 879-3900
FAX: (803) 879-0111

LIDLAW ENVIRONMENTAL SERVICES
THERMAL TREATMENT, INC.

100-YEAR FLOODPLAIN

SCALE
AS SHOWN

DATE
1/94

PROJECT NO.
16-30912

TABLE 3-1
STORM WATER ANALYTICAL DATA - EXISTING BURNERS

PARAMETER	UNITS	GRAB	COMPOSITE
Nitrobenzene	ug/L	ND	ND
2,6-Dinitrotoluene	ug/L	ND	ND
2,4-Dinitrotoluene	ug/L	ND	ND
Benzene	ug/L	< 1	
Toluene	ug/L	< 1	
Ethylbenzene	ug/L	< 1	
Xylene, Total	ug/L	< 3	
Sb	ug/L	< 10	< 10
As	ug/L	< 3	< 3
Ba	ug/L	70	59
Be	ug/L	< 5	< 5
Cd	ug/L	< 5	< 5
Cr	ug/L	< 10	< 10
Cu	ug/L	150	77
Pb	ug/L	< 200	< 200
Mg	ug/L	1100	930
Hg	ug/L	< 0.20	0.36
Ni	ug/L	< 40	< 40
Se	ug/L	< 6	< 6
Ag	ug/L	< 1	< 1
Th	ug/L	< 3	< 3
Mg, Dissolved	ug/L	620	560
COD	mg/L	31	35
CN	mg/L	< 0.01	
Ammonia	mg/L	< 0.1	< 0.1
Nitrate + Nitrite	mg/L	0.18	0.095
TKN	mg/L	1	0.65
O & G	mg/L	< 5.1	
Phenolics, Total	mg/L	< 0.01	0.01
Phosphorus, Total	mg/L	< 0.1	< 0.1
TDS	mg/L	96	110
TSS	mg/L	16	27
TOC	mg/L	13	14
pH	su	5.3	

summaries of temperature and precipitation for the period 1975-1992; and (2) Thirty-year normals (1951-1980) of various monthly data at Alexandria, La. (Climatology No. 20). This data was used in determining the appropriate storm intensity and accumulation period used in the screening assessment (Section 3.2.2.3).

3.2.2 SCREENING ASSESSMENT

3.2.2.1 Overview

The storage, preparation and treatment areas of the facility have secondary containment to preclude contaminant dispersal via runoff of precipitation. The storage magazines and preparation building are completely enclosed to prevent precipitation from contacting the waste. In addition, thermal treatment units have covers to minimize the amount of precipitation contacting the treatment units.

The concrete pad surrounding the thermal treatment units is the primary or worst case waste management area in terms of potential for contaminants to leave the facility via surface runoff. Particulate deposition on the pad during treatment and the potential for spillage of waste material or ash during transfer are the primary methods whereby contaminants could be deposited on the pad. Therefore, the surface water assessment is targeted at the thermal treatment area and the acute impact of potentially contaminated storm water runoff on nearby receiving waters.

Each of the 20 thermal treatment units has a 16' x 16' concrete containment area. Therefore, spillage and fallout in the immediate vicinity of the treatment units will be contained. Also, spills on the surrounding pad will be removed to a treatment area or will be containerized immediately and are not considered to be a significant source of contaminants.

The screening risk assessment addresses deposition of heavy metal laden particulates on the

concrete pad and the retention pond between rainfall events. Factors such as emission rate, particle size and meteorological conditions will determine the quantity and pattern of deposition. During a significant rainfall event, contaminants may be washed from the pad into the retention pond located immediately northeast of the treatment area. The retention pond discharge will be sampled to determine if it is in compliance with discharge parameters established under the NPDES Storm Water Permit issued for the facility. Therefore, this runoff will be monitored under permitted guidelines.

As discussed in Section 3.1.1.1, Summerfield Branch is the nearest prominent surface water body with the potential to be impacted by the facility. The retention pond discharge will flow north through a natural drainage channel to an intermittent stream that enters Summerfield Branch west of Highway 471. The flow path distance to Summerfield Branch is approximately 1 mile.

The surface water screening assessment utilizes air quality modeling data discussed in Section V to predict depositional concentrations of metal particulates on the pad surrounding the thermal treatment units. Area precipitation data (Appendix 3-B) is used to predict the time interval between significant storm events. Under stated conditions, the calculated quantity of a target metal that accumulates on the pad between storm events is used to determine a concentration in the retention pond discharge. The impact of this discharge on Summerfield Branch serves as the basis for the screening assessment using available EPA Water Quality Criteria developed under the Clean Water Act.

3.2.2.2 Depositional Modeling of Heavy Metals

Section V describes the depositional modeling protocol for the air quality assessment. The metals Al, Ba, Be, Cr, Cu, Ni, Pb, Sb, Se, Zn, and Hg were modeled using the EPA Industrial Source Complex (ISC)-2 model to determine the ground level concentrations based upon calculated emissions from the thermal treatment units. As discussed in Section

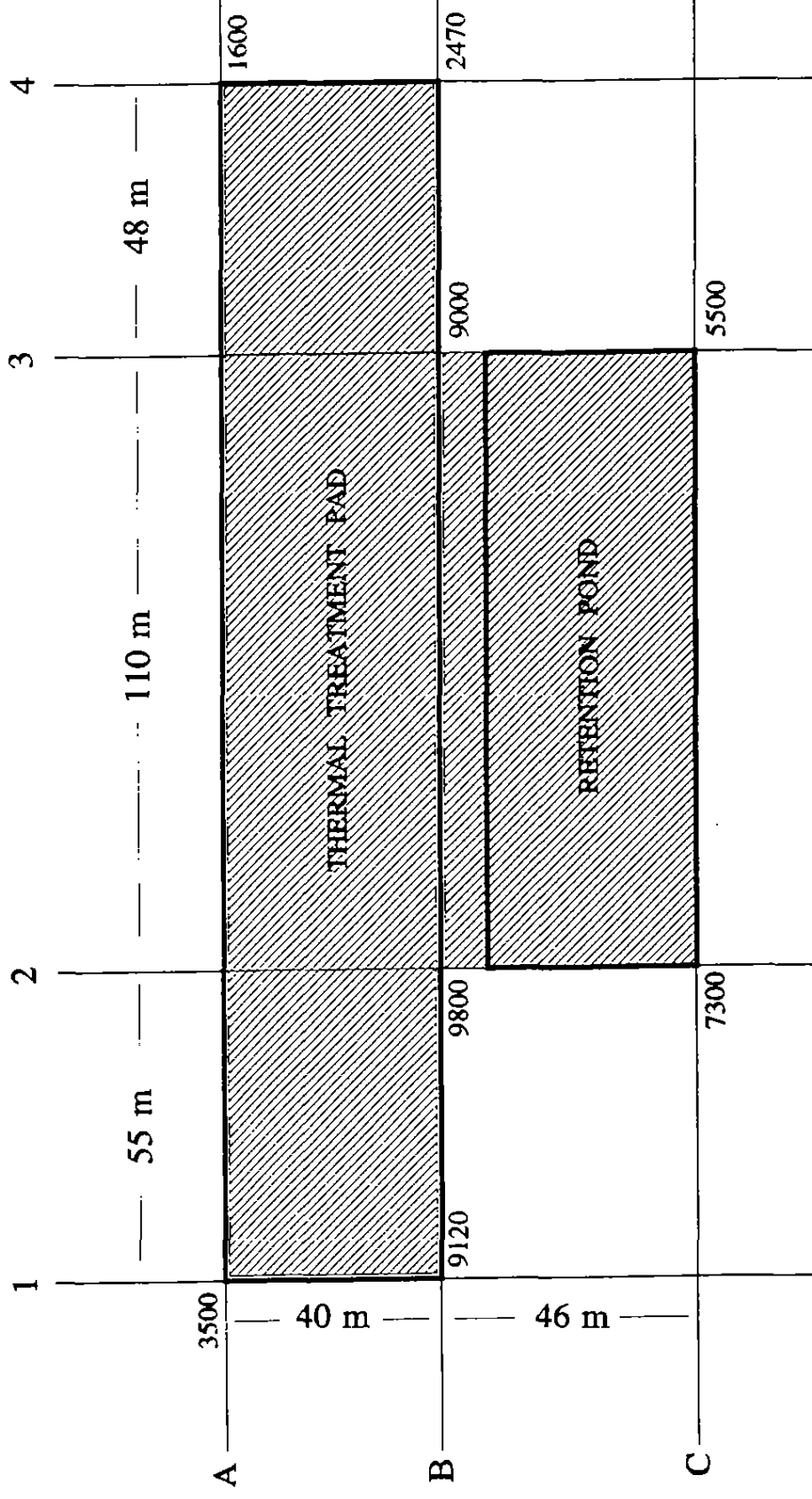
V, the facility will not burn compounds containing arsenic and cadmium as significant constituents of the waste stream. Therefore, these compounds were not included in the screening assessment.

An imaginary receptor grid was placed over the treatment area and the retention pond. Modeled unitized deposition rates were determined at each grid point by ERM (see Section V). Figure 3-4 is a plan view of the thermal treatment area and the retention pond with a grid overlay identifying the modeled average annual deposition rate ($\text{g}/\text{m}^2/\text{year}$) at each grid point. Each grid point is coded for use in calculating average metal concentrations over the pad and retention pond surfaces.

Two primary areas, A1/A4/B1/B4 and B2/B3/C2/C3, were used to determine the amount of each metal that would be present in the pond discharge. Appendix 3-C contains tables for each target metal with calculated metal deposition rates for each referenced grid point.

The total metal quantity deposited on the pad and the pond was determined by the following procedure:

- ▶ Modeled annual deposition rates were divided by 18 to represent an approximate 20 day average treatment period.
- ▶ Based upon model input parameters, the modeled deposition rate was divided by 20 to obtain a 1 g/s unitized deposition rate.
- ▶ The unitized deposition rate was multiplied by the metal emission rate (ERM - Section V) to determine the metal deposition rate over the 20 day period.
- ▶ The average deposition rate was calculated for each grid area and was multiplied by the surface area to obtain total metal deposited.
- ▶ Total metal deposited was multiplied by 80% to estimate the amount of metal that would discharge from the pond over a single storm event.



NOTE: GRID POINT VALUES REPRESENT MODELED DEPOSITION
 RATES FOR 20 BURNERS (g / m² / year)

 ViroGroup ETE DIVISION	METALS DEPOSITION GRID LAIDLAW ENVIRONMENTAL SERVICES THERMAL TREATMENT, INC. Colfax, Louisiana	FIGURE 3 - 4	SCALE 1cm = 12 m
			JOB NUMBER 16 - 30912
			FILE a : tt_mtl.s.grd
			DATE 1 - 94

The 20 thermal treatment pads (16' x 16') were not included in the treatment pad area calculation since these areas are fully contained and will not contribute to total metal runoff from the pad. However, during periods of precipitation these areas will be covered and will contribute to pond influent flow.

3.2.2.3 Retention Pond Discharge Metals Concentration

For a given depositional rate, the two variables that affect the concentration of a metal in the retention pond are: 1) length of time between rainfall events and 2) amount of rainfall per event. Where rainfall events of a given size have occurred historically in a particular area, the probability of that rainfall event occurring increases with the time interval between events. In terms of the assessment, a longer time interval would allow greater accumulation of particulates on the pad, assuming continuous uniform burns. However, the predicted rainfall quantity during a single event for a specified time period (e.g., 24 hours) would increase also, thus decreasing the concentration of contaminant in the retention pond due to dilution.

In order to model surface runoff from the pad and retention pond, ViroGroup has assumed a 1" rainfall event occurring over a maximum 24 hour period. Precipitation data for the Alexandria, Louisiana vicinity indicates the number of days per month which had precipitation at least 1" or greater. For data years 1975 - 1992, the number of days per month for a 1" rainfall occurrence ranged from 0 to 6 days. The weighted average for this occurrence was 1.58 days per month. Based upon this analysis and assuming uniform distribution, a 20 day period was selected as the treatment interval used to determine total metal generated.

The total surface area of the concrete pad and the 20 covered thermal treatment units is approximately 91,000 square feet. The surface area of the retention pond is approximately 54,500 square feet for a combined surface area of 145,500 square feet. A 1" rainfall will

generate approximately 12,125 cubic feet (90,695 gal) of water. The screening assessment assumes that all particulates are removed from the concrete pad during the rainfall event and are completely mixed inside the retention pond. It is estimated that 80% of the metal will discharge from the pond during any single storm event.

Under this scenario, a concentration for each metal constituent was determined by dividing total constituent mass by the total quantity of accumulated runoff within the pond, 90,695 gallons or 343,280 liters. Section 3.2.2.6 describes the procedures for calculating stream influent metal concentrations.

3.2.2.4 Surface Water Flow Assumptions

As a conservative first pass screening assessment, it was assumed that the retention pond discharge flowed to Summerfield Branch as mixed flow with all characteristics unchanged. Deposition in sediments was not considered.

Technical Release 55 (TR-55), first issued by the Soil Conservation Service in 1975, was used to model surface runoff from the retention pond and from the surrounding watershed that contributes to total flow. TR-55 presents simplified procedures for estimating runoff and peak discharges in small watersheds. The model uses a curve number (CN) for the soil and cover in the target area and a time of concentration to develop a hydrograph for a particular storm event.

The 1" storm event used in the screening assessment was synthetically distributed in the model using SCS distribution Type III. The drainage area was divided into two separate areas: 1) the thermal treatment pad and retention pond, and 2) the surrounding watershed that drains into Summerfield Branch at Highway 471. The hydrographs for each of these areas are contained in Appendix 3-D.

The peak discharge into Summerfield Branch from the thermal treatment pad and retention pond is 1 cfs for a 1" rainfall. The remaining watershed peak discharge is 3 cfs; however, this hydrograph shows a discharge of 2 cfs reaching the branch at approximately the same time as the pond discharge. Therefore, the watershed contribution of 2 cfs was used to determine final influent concentration of metals as discussed in Section 3.2.2.6. There are some limitations to the TR-55 model in calculating runoff from the surrounding watershed due to the fact that total runoff was less than 0.5".

3.2.2.5 Water Quality Criteria

As discussed in Section 3.2.1.1, neither Summerfield Branch nor Bayou Grappe have designated water uses or quality criteria under the Louisiana Administrative Code and are not included in the USGS Water Data Report. EPA Water Quality Criteria as summarized in RFI Guidance Document EPA 530/SW-89-031 as well as Drinking Water Regulations and Health Advisories (December 1993) were used to screen each of the metals determined to be present on the pad. Since storm water discharges are intermittent, long term impacts cannot be adequately assessed using a screening procedure.

Table 3-2 contains several criteria used to assess the modeled target metal concentrations in Summerfield Branch. Chronic effects through human consumption of surface water is not a concern for Summerfield Branch or Bayou Grappe. However, an evaluation of the criteria for human exposure is provided through a review of Maximum Contaminant Level (MCL's) for drinking water supplies. Table 3-2 also contains maximum concentration values for Freshwater Acute Aquatic Life Criteria as taken from the RFI guidance document.

3.2.2.6 Stream Impact Assessment

The maximum mass flow rate of metal in the retention pond discharge is calculated as:

$$C_i \times Q_i = \text{mass flow rate, where}$$

C_i = Initial concentration

Q_i = Retention pond discharge rate at the point of concern

The screening assessment assumes that each target metal is uniformly mixed in the retention pond and is released through the discharge pipe. Appendix 3-D contains the discharge analysis used to determine the flow rate at the point the pond discharge enters Summerfield Branch. The concentration of each metal discharging to the stream is calculated as follows:

$$C_f = \frac{C_i(Q_i)}{Q_i + Q_s} \text{ where,}$$

C_f = Final metal concentration in the stream influent

Q_s = Overland flow contribution to the pond discharge

Table 3-2 contains the influent metals concentrations using this equation and assuming that the total quantity of metal deposited is uniformly mixed with the total quantity of runoff from the treatment pad and retention pond. Appendix 3-C contains an analysis of the total metals deposited and the calculated stream influent concentrations.

3.2.2.7 Summary

For most of the target metals, the screening assessment showed that stream influent concentrations were significantly higher than the Fresh Acute Aquatic Life Criteria. Antimony, beryllium and hexavalent chromium were all less than one order of magnitude of the standard. Other metals concentrations ranged from 1 to 4 orders of magnitude above the aquatic life standard. Aluminum and barium do not have a standard under this criteria.

The range of exceedance of metals concentrations above the MCL was approximately the same as for the aquatic life standard (i.e., 1 to 4 orders of magnitude). The concentration of zinc exceeded the standard by 2.74 times.

Table 3-2 also contains a comparison of the assessment criteria with actual storm water data

TABLE 3-2

SURFACE WATER METALS CONCENTRATIONS AND ASSESSMENT CRITERIA

PARAMETER	MODELED STREAM INFLUENT CONCENTRATIONS (mg/L)	SDWA MAXIMUM CONTAMINANT LEVELS (ug/L)	FRESH ACUTE AQUATIC LIFE CRITERIA (ug/L)	EXISTING SITE STORM WATER RUNOFF CONC. (GRAB - ug/L)
ALUMINUM	1028	(50 - 200) ¹		
ANTIMONY	13.7	6	9000 (LOEL)	< 10
BARIUM	822	2000		70
BERYLLIUM	0.140	4	130	< 5
CHROMIUM ⁺⁶	0.100		16	
COPPER	13.7	1300 ²	18	150
LEAD	127		82	< 200
MERCURY	39.7	2	2.4	< 0.20
NICKEL	15.1	100	1400	< 40
SELENIUM	1233	50	260	< 6
ZINC	13.7	5000	120	

NOTE:

1 - Represents secondary maximum contaminant levels

2 - MCLG (Maximum Contaminant Level Goal)

(LOEL) - Lowest Observed Effect Level

from the existing burn site. This data shows the actual runoff concentrations from the grab samples were significantly less than the standards to the levels of detection used. The concentration of copper did exceed the aquatic life criteria but was well below the MCL.

It is apparent that the modeled concentrations are well outside the expected concentrations based upon actual sampling data. There are several factors affecting the actual runoff concentrations and the modeled results that could account for this discrepancy. First, the depositional model used can provide only approximate values near the source. This limitation may have skewed the unitized deposition rates to be artificially high in the vicinity of the treatment pad and the retention pond. Also, conservative emission rates were used in the model based upon previous trial burn data. Attenuation of target metals in the soil would also contribute to the lower concentrations observed in the storm water runoff from the existing burn site.

Under actual operation the thermal treatment pad will be maintained to minimize the accumulation of material between rainfall events. The discharge gate from the retention pond will remain closed in order to hold storm water runoff. The discharge pipes from the thermal treatment pad may also be closed during minor rainfall events in order to retain runoff on the pad.

Stormwater runoff from the treatment pad will be monitored under the facility NPDES storm water permit. Laidlaw will also monitor storm water on a routine basis to determine if the metals concentrations are consistent with those obtained from existing burn site runoff (see Table 3-1). In the event the storm water cannot be directly discharged it will be pumped from the pond or the treatment pad and will be transported to an appropriate offsite facility for treatment. Thus, facility operations will not adversely impact the quality of surface waters near the property.

EXHIBIT 3-1
ACOE JURISDICTIONAL DETERMINATION



DEPARTMENT OF THE ARMY

MOBILE DISTRICT, CORPS OF ENGINEERS
2101 NORTH FRONTAGE ROAD
MOBILE, MISSISSIPPI 36680-4101

June 15, 1993

REPLY TO
ATTENTION OF.

Operations Division
Regulatory

SUBJECT: Jurisdictional Determination--43-Acre Tract,
R and D Fabrication and Manufacturing, Incorporated, Grant
Parish, Louisiana

Ms. Patricia McCoy
Espey, Buxton and Associates, Incorporated
Post Office Box 519
Austin, Texas 78767-0519

Dear Ms. McCoy:

This is in response to your recent inquiry requesting that the U.S. Army Corps of Engineers review a wetland determination made by your office for property located in section 19, T7N-R3W, Grant Parish, Louisiana.

Based upon the information provided and that obtained from our investigation, we have determined that there are no jurisdictional wetlands within the limits of the property. However, we have determined that there are other regulated waters of the United States in the area. These waters are confined to the intermittent, bank-contained streams which drain the property. The approximate location of these streams are depicted on the enclosed map (enclosure 1).

Department of the Army permit requirements for filling less than 1 acre of these streams will be authorized by the Nationwide Permit found at 33 CFR Appendix A to Part 330.B(26), provided the activity complies with the Special Conditions (enclosure 2), the Nationwide Permit Conditions (enclosure 3), the Regional Conditions (enclosure 4), and further provided you furnish a copy of your water quality certification from the State of Louisiana to this office. You may contact the Louisiana Department of Environmental Quality at (504) 765-0664 or write to the Louisiana Department of Environmental Quality, Office of Water Resources, P.O. Box 82215, Baton Rouge, Louisiana 70884-2215.

It is your responsibility to read and become familiar with the enclosed conditions in order for you to ensure that any proposed activities in the area comply with the Nationwide Permit.

This jurisdictional determination is valid for a period of 2 years or until the Nationwide Permit is modified, suspended, or revoked. Activities which are under construction or that are under contract to commence in reliance upon a Nationwide Permit will remain authorized, provided the activity is completed within 12 months from the date of any subsequent modification, expiration, or revocation of the Nationwide Permit.

If we may be of any assistance in this matter, please contact Mr. Charles Allred, telephone (601) 631-5546 or telefax (601) 631-6316.

Sincerely,

For: Kenneth P. Mosley

Kenneth P. Mosley
Chief, Enforcement Section
Regulatory Branch

Enclosures

Copy Furnished:

U.S. Environmental Protection Agency
Wetlands Protection Section (6E-F)
1445 Ross Avenue
Dallas, Texas 75202-2733

EXHIBIT 3-2
LOUISIANA WATER QUALITY CERTIFICATION



State of Louisiana
Department of Environmental Quality



Edwin W. Edwards
Governor

OCT 14 1993

Kai David Midboe
Secretary

WQC 930715-02

ViroGroup, Inc.
417 S. Buncombe Road
Suite 1
Greer, SC 29650

Attention: Robert J. Hall, Agent for R & D Fabricating and Manufacturing

Gentlemen:

RE: Proposal for R & D Fabricating and Manufacturing to fill less than one acre of a waterway, Section 19, T7N-R3W, Grant Parish, LA.

This is to acknowledge that you have completed the requirements for Water Quality Certification for the above referenced proposal.

It is our opinion that your proposed project will not violate water quality standards of the State of Louisiana, therefore, we offer no objection to this project provided: 1) that the fill material used is free of contaminants; and 2) that a state wastewater discharge permit is obtained from this office for any discharges from the site.

In accordance with statutory authority contained in the Louisiana Revised Statutes of 1950, Title 30, Chapter 11, Part IV, Section 2074 A(3) and provisions of Section 401 of the Clean Water Act (P.L. 95-217), the Office of Water Resources certifies that it is reasonable to expect that water quality standards of Louisiana provided for under Section 303 of P.L. 95-217 will not be violated.

Sincerely,

J. Dale Givens, Assistant Secretary
Office of Water Resources

JDG:MLB
c: Corps of Engineers, New Orleans District
Coastal Management Division



recycled paper

OFFICE OF WATER RESOURCES P.O. BOX 92215 BATON ROUGE, LOUISIANA 70884-2215

AN EQUAL OPPORTUNITY EMPLOYER



EXHIBIT 3-3
NPDES STORM WATER NOTIFICATION

NPDES
FORMUnited States Environmental Protection Agency
Washington, DC 20460

Notice of Intent (NOI) for Storm Water Discharges Associated with Industrial Activity Under the NPDES General Permit

Submission of this Notice of Intent constitutes notice that the party identified in Section I of this form intends to be authorized by a NPDES permit issued for storm water discharges associated with industrial activity in the State identified in Section II of this form. Becoming a permittee obligates such discharger to comply with the terms and conditions of the permit. ALL NECESSARY INFORMATION MUST BE PROVIDED ON THIS FORM.

I. Facility Operator Information

Name: L, A, I, D, L, A, W, E, N, V, S, V, C, S, (, T, T,), I, N, C, Phone: 3, 1, 8, 16, 2, 7, 13, 4, 4, 3, 1
Address: P, O, B, O, X, 4, 8, 2, Status of Owner/Operator: ☒ P
City: C, O, L, F, A, X, State: L, A, ZIP Code: 7, 1, 4, 1, 7, -

II. Facility/Site Location Information

Name: L, A, I, D, L, A, W, E, N, V, S, V, C, S, (, T, T,), I, N, C, Is the Facility Located on Indian Lands? (Y or N) ☐ N
Address: H, I, G, H, W, A, Y, 4, 7, 1
City: C, O, L, F, A, X, State: L, A, ZIP Code: 7, 1, 4, 1, 7, -
Latitude: 3, 1, 3, 4, 4, 5 Longitude: 0, 9, 2, 4, 3, 0, 0 Quarter: Section: Township: Range:

Activity Information

MS4 Operator Name:
Receiving Water Body: B, A, V, O, U, G, R, A, P, P, E,
If You are Filing as a Co-permittee, Are There Existing Quantitative Data? (Y or N) ☐ N Is the Facility Required to Submit Monitoring Data? (1, 2, or 3) ☒ 2
Enter Storm Water General Permit Number:
SIC or Designated Activity Code: Primary: 4, 9, 5, 3 2nd: H, Z, 1 3rd: 4th:
If This Facility is a Member of a Group Application, Enter Group Application Number:
If You Have Other Existing NPDES Permits, Enter Permit Numbers:

IV. Additional Information Required for Construction Activities Only

Project Start Date: Completion Date:
Estimated Area to be Disturbed (in Acres): Is the Storm Water Pollution Prevention Plan in Compliance with State and/or Local Sediment and Erosion Plans? (Y or N) ☐

V. Certification: I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for such violations.

Name: J, A, M, E, S, E, G, A, L, L, I, O, N, S, R, Date: 1, 2, 10, 2, 19, 3

Signature:

Please See Instructions Before Completing This Form

Form Approved. OMB No. 2040-0088
Approval expires: 6-31-88NPDES
FORMUnited States Environmental Protection Agency
Washington, DC 20460Notice of Termination (NOT) of Coverage Under the NPDES General Permit
for Storm Water Discharges Associated with Industrial Activity

Submission of this Notice of Termination constitutes notice that the party identified in Section II of this form is no longer authorized to discharge storm water associated with industrial activity under the NPDES program. ALL NECESSARY INFORMATION MUST BE PROVIDED ON THIS FORM.

I. Permit Information

NPDES Storm Water
General Permit Number:

L A R Q O A 7 9 8

Check Here if You are No Longer
the Operator of the Facility:Check Here if the Storm Water
Discharge is Being Terminated:

II. Facility Operator Information

Name: R & D F A B R I G A T I N G A N D M E G I N C Phone: 3 1 8 6 2 7 3 4 4 8

Address: P O B O X 4 8 2

City: C O L F A X State: L A ZIP Code: 7 1 4 1 7

III. Facility/Site Location Information

Name: R & D F A B R I C A T I N G A N D M E G I N C

Address: H I G H W A Y 4 7 1

C O L F A X State: L A ZIP Code: 7 1 4 1 7

Latitude: 3 1 3 4 4 5 Longitude: 0 9 2 4 3 0 Quarter: Section: Township: Range:

IV. Certification: I certify under penalty of law that all storm water discharges associated with industrial activity from the identified facility that are authorized by a NPDES general permit have been eliminated or that I am no longer the operator of the facility or construction site. I understand that by submitting this Notice of Termination, I am no longer authorized to discharge storm water associated with industrial activity under this general permit, and that discharging pollutants in storm water associated with industrial activity to waters of the United States is unlawful under the Clean Water Act where the discharge is not authorized by a NPDES permit. I also understand that the submittal of this Notice of Termination does not release an operator from liability for any violations of this permit or the Clean Water Act.

Print Name: R I C H A R D C R A I N Date: 1 2 0 2 9 3

Signature:

Richard Crain

Instructions for Completing Notice of Termination (NOT) Form

Who May File a Notice of Termination (NOT) Form

Permittees who are presently covered under the EPA issued National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Industrial Activity may submit a Notice of Termination (NOT) form when their facilities no longer have any storm water discharges associated with industrial activity as defined in the storm water regulations at 40 CFR 122.26 (b)(14), or when they are no longer the operator of the facilities.

For construction activities, elimination of all storm water discharges associated with industrial activity occurs when disturbed soils at the construction site have been fully stabilized and temporary erosion and sediment control measures have been removed or will be removed at an appropriate time, or that all storm water discharges associated with industrial activity from the construction site that are authorized by a NPDES general permit have otherwise been eliminated. Final stabilization means that all soil-disturbing activities at the site have been completed, and that a uniform perennial vegetative cover with a density of 70% of the cover for upland areas and areas not covered by permanent structures has been established, or equivalent permanent stabilization measures (such as the use of riprap, geotextiles, or geocells) have been employed.

Where to File NOT Form

Send this form to the following address:

Storm Water Notice of Termination
P.O. Box 1185
Newington, VA 22122

Completing the Form

Type or print, using upper-case letters, in the appropriate areas only. Please place each character between the marks. Abbreviate if necessary to stay within the number of characters allowed for each item. Use only one space for breaks between words, but not for punctuation marks unless they are needed to clarify your response. If you have any questions about this form, call the Storm Water Hotline at (703) 621-4823.

PLEASE SEE REVERSE OF THIS FORM FOR FURTHER INSTRUCTIONS

APPENDIX 3-A
WETLANDS DETERMINATION REPORT

EH&A Project No. 14844
Document No. 930314

WETLAND DETERMINATION FOR
R&D FABRICATION AND MANUFACTURING, INC.
43 ACRES IN
GRANT PARISH, LOUISIANA

Prepared for:

R&D Fabrication and Manufacturing, Inc.
P.O. Box 482
Colfax, Louisiana 71417

ATTN: Mr. Richard Crain

Prepared by:

Espey, Huston & Associates, Inc.
800 West Sam Houston Parkway South
Suite 201
Houston, Texas 77042

May 1993

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3-1	PLANT SPECIES OBSERVED

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RESULTS

The study area was comprised of only non-wetland areas. The majority of the tract was best characterized as steep topography (5-30% slopes) with natural, intermittent drainage features. The primary vegetation type was pine-hardwood. It appeared that the tract had been logged for commercial timber approximately 15 years ago. In some small areas of the tract, selected pine trees were being harvested for pulpwood.

The natural drainages on the tract appeared intermittent in nature with a very limited number of small, non-permanent pools. The width of the drainages varied from less than one foot to approximately 3 feet before exiting the tract boundaries at various locations (Figure 4-1). Because flow was so minimal in these drainages, the average flow was not calculated and it was assumed to be less than 5 cfs.

Vegetation

Only one major vegetation community type was observed on the tract: pine-hardwood. Three species of pine (loblolly, shortleaf and longleaf) were observed at various locations on the tract, oftentimes with the three growing next to each other. Although several species of hardwoods were present, the dominant hardwood was blackjack oak which could be found growing on the ridge tops, sideslopes and next to the drainages. Other dominant overstory and midstory species were sweetgum, southern red oak, and black gum. Regeneration of pine seedlings was good to moderately good in most areas. The midstory was often thick and ground cover and herbaceous vegetation were sparse or conspicuously absent. In some areas where the ground had been disturbed and shading partially eliminated, bracken fern (*Pteridium aquilinum*, FACU) and partridge-berry were common.

Hydrology

The only field indicator of wetland hydrology observed at the sample sites was saturated soil. The area had received approximately three inches of rain two days prior. Except for the Rigolette series, none of the soils were predisposed to hydric conditions, especially when topography is considered on the site. All of the soil types to be encountered on the tract were at least moderately well drained. Although the mapped soil type is known to contain seepages, no seepages were observed anywhere on the tract.

Soils

The Rigolette-Kisatchie association is also reported to have inclusions of Briley, Cadeville, Ruston and Smithdale soil units. The Briley and Kisatchie series were identified at SS1 and SS2, respectively. The soil profile and characteristics at SS3 did not offer a clear cut identification of any of the inclusions. However, it was thought that this sample site was located in an interface area of a Rigolette and Cadeville unit. A confirmation point identified as the Briley series was located near a sandstone outcrop on the northeast side of the property.

Field indicators of hydric soils were encountered at only one of the three sample plots. Low-chroma matrix color was observed at SS2 (Kisatchie series). Although the chroma was 2 and mottling was prominent (in the A2 horizon) no other hydric soil indicators were observed. In addition, vegetation was not hydrophytic and no field indicators of wetland hydrology were observed.

SUMMARY

No areas on the 43-acre tract were identified as wetlands. Of the three criteria required for wetland identification, only one sample site (SS2) exhibited only hydric soil indicators. But SS2 had neither a dominance of wetland vegetation, nor field indicators of wetland hydrology. Soil saturation at each of the sample sites, as noted on the data sheets, was thought to be attributed to recent heavy rains in the area. Because the boundary of the 43-acre tract was cleared and easily accessible, a cursory look was made to the adjacent forest. Although no sample points were established outside the boundary, no observable indicators of wetlands or jurisdictional areas were noted. Terrain and vegetation appeared similar to the subject tract. The prevalence of nonwetlands could be attributed to the steep topography and sandy soils which facilitated development of the natural drainage patterns in the hilly terrain.

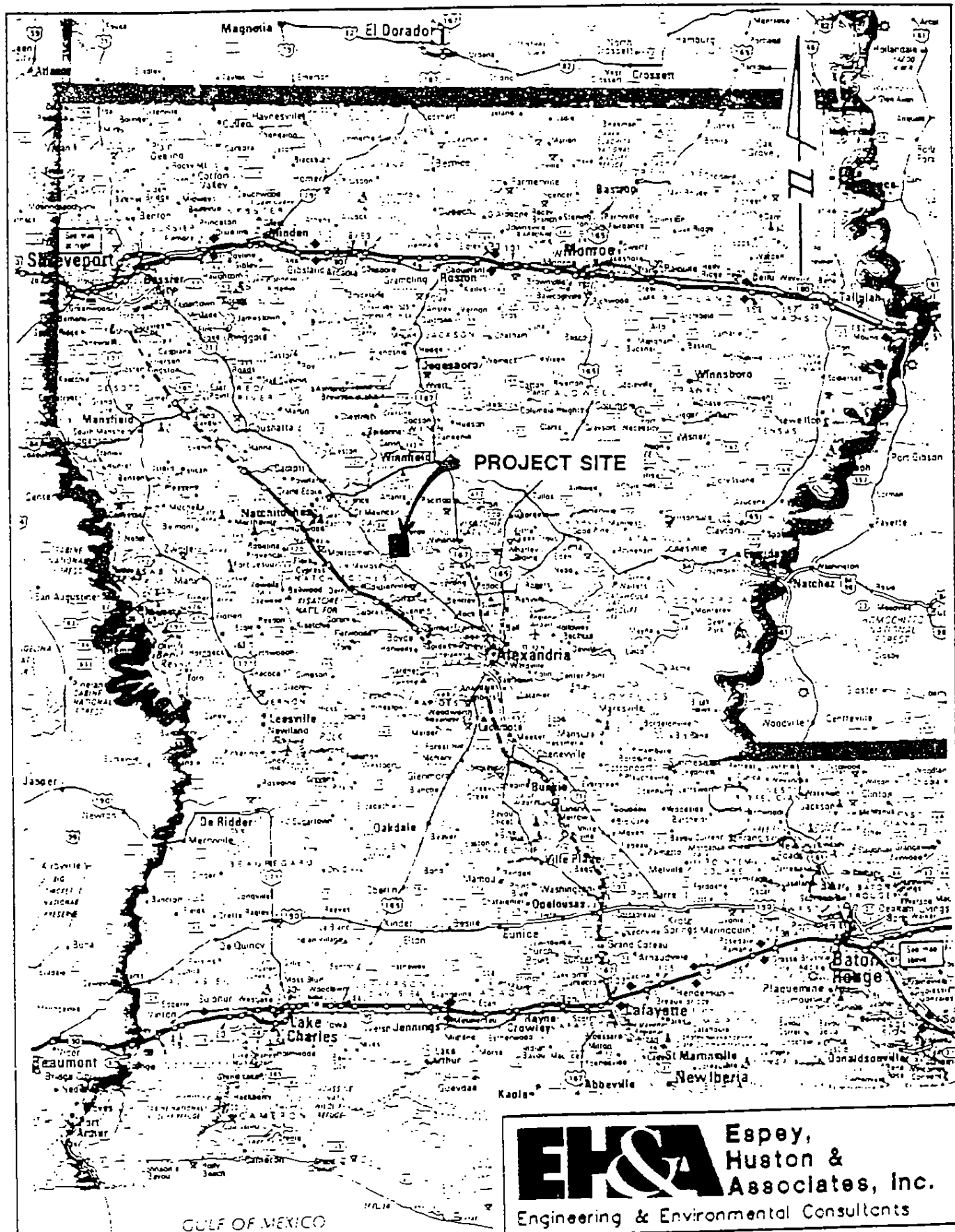
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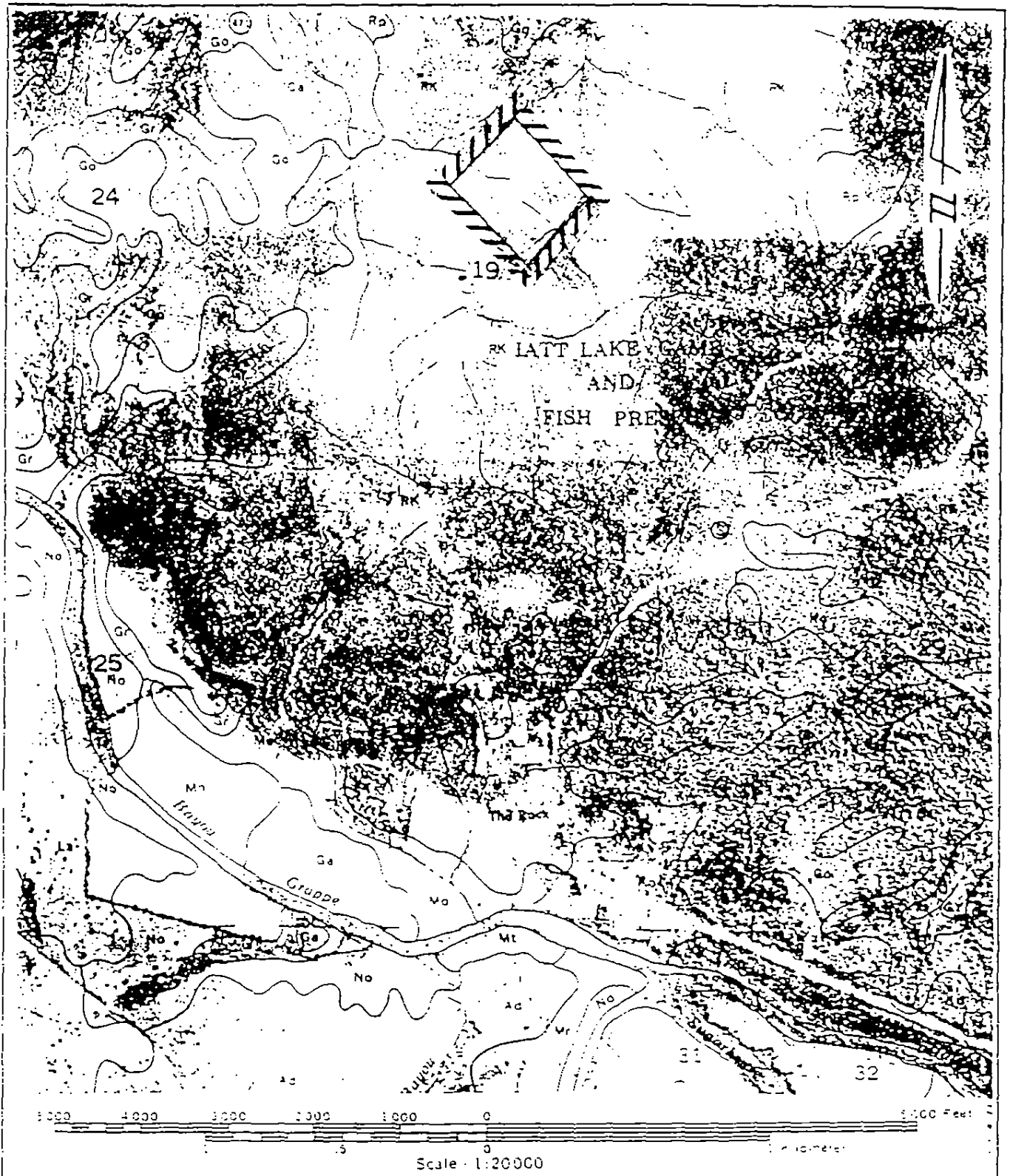
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2



EH&A Espey,
Huston &
Associates, Inc.
Engineering & Environmental Consultants

**FIGURE 1-1
VICINITY MAP**



EH&A Espey,
Huston &
Associates, Inc.
Engineering & Environmental Consultants

FIGURE 2-1
SOILS MAP

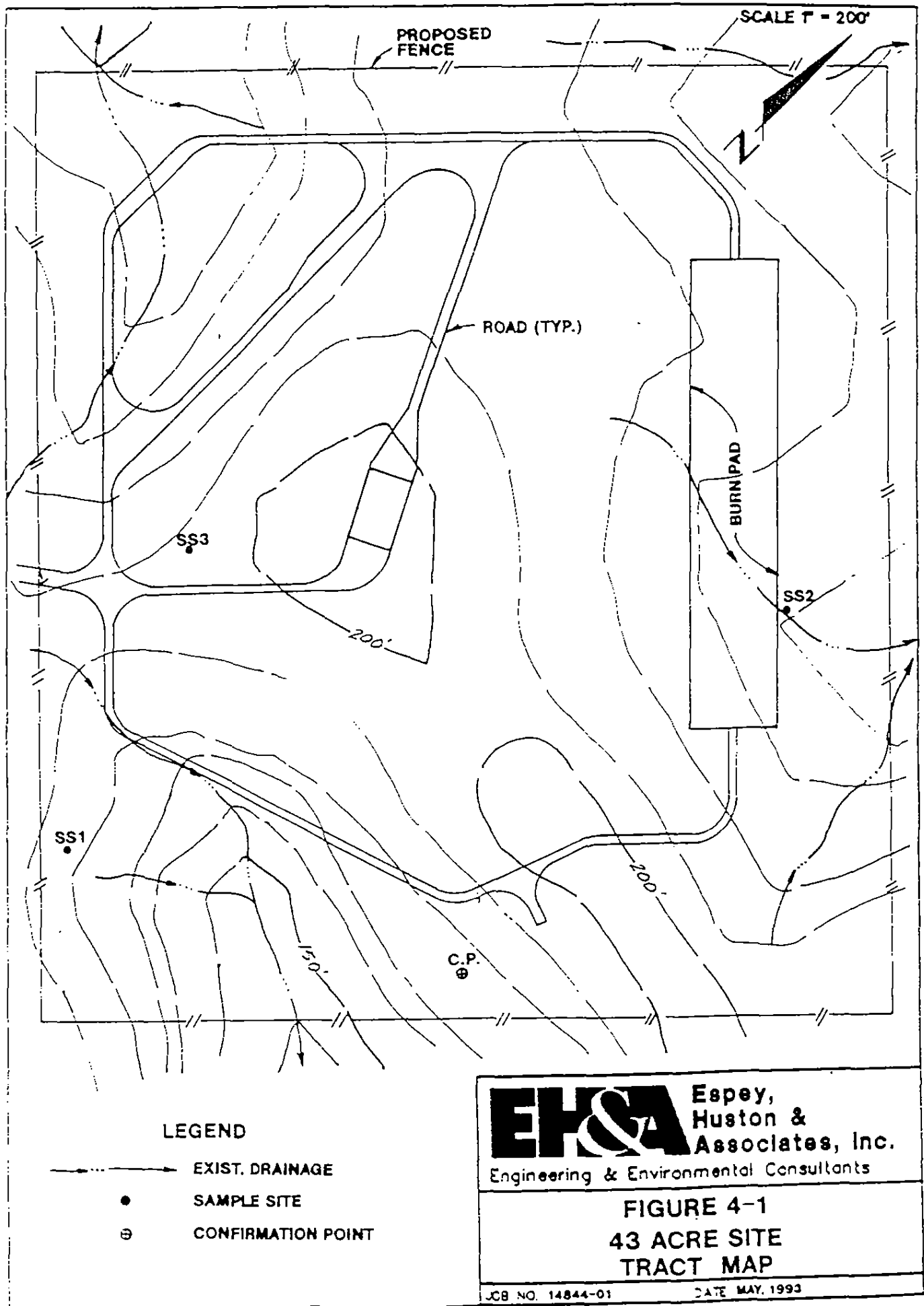


TABLE 2-1

FIELD INDICATORS OF HYDRIC SOILS

1. Organic soils
2. Histic epipedons
3. Sulfidic materials
4. Aquic or peraquic moisture regimes
5. Reducing soil conditions
6. Soil colors - gleyed, low-chroma and low-chroma/mottled soils
7. Soils appearing on hydric soils list
8. Iron and manganese concretions
9. Coarse-textured or sandy hydric soils
 - a. High organic matter in the surface horizon
 - b. Dark vertical streaking of subsurface horizon by organic matter
 - c. Wet spodosols
 - d. New sandbars

TABLE 2-2
FIELD INDICATORS FOR WETLAND HYDROLOGY

1. Visual observation of inundation
2. Visual observation of soil saturation
3. Watermarks on woody vegetation
4. Drift lines
5. Sediment deposits
6. Drainage patterns within wetlands

TABLE 3-1

PLANT SPECIES OBSERVED

<u>Scientific Name</u>	<u>Common Name</u>	<u>Indicator Status</u>
<i>Bignonia capreolata</i>	trumpet-creeper	FAC
<i>Chasmanthium sessiliflorum</i>	long-leaf spikegrass	FAC+
<i>Liquidambar styraciflua</i>	sweetgum	FAC+
<i>Muchella repens</i>	partridge-berry	FACU+
<i>Nyssa sylvatica</i>	black gum	FAC
<i>Pinus taeda</i>	loblolly pine	FAC
<i>Quercus marilandica</i>	blackjack oak	UPL
<i>Quercus falcata</i>	souther red oak	FACU-
<i>Sassafras albidum</i>	sassafras	FAC
<i>Smilax rotundifolia</i>	common greenbrier	FAC
<i>Symplocos tinctoria</i>	horse-sugar	FAC
<i>Vaccinium elliotii</i>	Elliott blueberry	FAC+
<i>Vaccinium arboreum</i>	farkleberry	FACU
<i>Vitis rotundifolia</i>	muskadine grape	FAC
<i>Vitis aestivalis</i>	summer grape	FAC

APPENDIX A
FIELD DATA SHEETS

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: 43 - Acres Colfax, LA
Applicant/Owner: Viro Group/MP
Investigator: P. McCoy & J. Gregory

Date: 4 MAY 93
County: Grant Parish
State: Louisiana

Do Normal Circumstances exist on the site? ☒ Yes ☐ No
Is the site significantly disturbed (Atypical Situation)? ☐ Yes ☒ No
Is the area a potential Problem Area? ☐ Yes ☒ No
(If needed, explain on reverse.)

Community ID: Pine/Uplands
Transect ID: _____
Plot ID: 551

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. <u>P. taeda</u>	<u>T</u>	<u>FAC</u>	9. _____	_____	_____
2. <u>P. taeda</u>	<u>Shp</u>	<u>FAC</u>	10. _____	_____	_____
3. <u>Quercus Maillardica</u>	<u>T</u>	<u>UPL</u>	11. _____	_____	_____
4. <u>Liquidambar styraciflua</u>	<u>Shp</u>	<u>FAC+</u>	12. _____	_____	_____
5. <u>Viburnum arboreum</u>	<u>Sh</u>	<u>FACU</u>	13. _____	_____	_____
6. <u>Vitis rotundifolia</u>	<u>V</u>	<u>FAC</u>	14. _____	_____	_____
7. <u>Mitchella repens</u>	<u>H</u>	<u>FACU+</u>	15. _____	_____	_____
8. <u>Symphoricarpos latifolia</u>	<u>H</u>	<u>FAC</u>	16. _____	_____	_____

Percent of Dominant Species that are OBL, FACW or FAC
(excluding FAC). FAC-neutral = 25%

Remarks: Logged about 15 years prior; Lots of FAC's but leans toward drier regimes

HYDROLOGY

Recorded Data (Describe in Remarks):
____ Aerial Photographs
____ Other
____ No Recorded Data Available

Field Observations:

Depth of Surface Water: N/A (m)
Depth to Free Water in Pit: N/A (m)
Depth Saturated Soil: 8.0 (m)

Wetland Hydrology Indicators:

Primary Indicators:

☐ Inundated
☒ Saturated in Upper 12 inches
☐ Water Marks
☐ Drift Lines
☐ Sediment Deposits
☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):

☐ Oxidized Root Channels in Upper 12 inches
☐ Water-Stained Leaves
☐ Local Soil Survey Data
☐ FAC-Neutral Test
☐ Other (Explain in Remarks)

Remarks: 3" of rain 2 days prior, soil saturated @ 12"; overlying sand allows rapid percolation to B horizon. No other indic of wet hydrology.

Fac: Biley LFSu
 Map Unit Name
 (Series and Phase): RK - Rigallotte - Kistahie Assoc.
 Taxonomy (Subgroup): Arenic Paludchult

Drainage Class: well drained
 Field Observations
 Confirm Mapped Type? ☒ Yes ☐ No

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretion, Structure, etc.
0-0.5	D	—	—	—	leaf litter, needles
0.5-7.5	A	10YR 4/2	—	—	sand
7.5-18	B	10YR 6/4-6/6	10YR 4/2 5YR 5/6	low coarse dist.	loamy sand

Hydric Soil Indicators:

- ☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☐ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed

- ☒ Low-Chroma Colors
☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soils
☐ Organic Streaking in Sandy Soils
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: Soil has low chroma (2) but no mottles assoc.; site is typical of side slopes on this tract; Inclusion of Biley LFSu

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☐ Yes ☒ No
 Wetland Hydrology Present? ☐ Yes ☒ No
 Hydric Soils Present? ☐ Yes ☒ No

Is this Sampling Point Within a Wetland? ☐ Yes ☒ No

Remarks: Area is typical of well drained side slopes on this tract

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 CCE Wetlands Delineation Manual)

Project/Site: 43 - Acres Colfax, LA
Applicant/Owner: VIRO GROUP / MD
Investigator: P. McCoy & J. Gregory

Date: 4 MAY 93
County: Grant Parish
State: Louisiana

Do Normal Circumstances exist on the site: ☒ Yes ☐ No
Is the site significantly disturbed (Atypical Situation)? ☐ Yes ☒ No
Is the area a potential Problem Area? ☐ Yes ☒ No
(If needed, explain on reverse.)

Community ID: Wood, also drainage
Transect ID: —
Plot ID: 442

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
① <i>Quercus falcata</i>	T	FACU-	⑨ <i>Chamaenerium semiliflorum</i>	H	FACT
② <i>Q. marilandica</i>	T	UPL	⑩ <i>Mitchella repens</i>	H	FACU+
3. <i>Pinus taeda</i>	T	FAC	11. _____	_____	_____
④ <i>Liquidambar styraciflua</i>	Sap	FACT	12. _____	_____	_____
5. <i>Nyssa sylvatica</i>	Sap	FAC	13. _____	_____	_____
6. <i>P. taeda</i>	Sap	FAC	14. _____	_____	_____
⑦ <i>Vaccinium arboreum</i>	Sh	FACU	15. _____	_____	_____
⑧ <i>V. ellipticum</i>	Sh	FAC+	16. _____	_____	_____

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC): FAC-neutral = 43%

Remarks: 90-95% leaf litter; H sparse; typical young pine-hardwood stand

HYDROLOGY

Recorded Data (Describe in Remarks):
☐ Aerial Photographs
☐ Other
☐ No Recorded Data Available

Wetland Hydrology Indicators:

Primary Indicators:

☐ Inundated
☒ Saturated in Upper 12 Inches Surface
☐ Water Marks
☐ Drift Lines
☐ Sediment Deposits
☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):

☐ Oxidized Root Channels in Upper 12 Inches
☐ Water-Stained Leaves
☐ Local Soil Survey Data
☐ FAC-Neutral Test
☐ Other (Explain in Remarks)

Field Observations:

Depth of Surface Water: N/A (m)
Depth to Free Water in Pit: N/A (m)
Depth Saturated Soil: 0 (m)

Remarks: 3" rain 2 days prior; more water retention in A horizon b/c of loam characteristics; site appears well drained b/c of slope + proximity to drainage feature

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site: 43 - Acre Colfax, LA
Applicant/Owner: VISO Group / MP
Investigator: P. McCoy & J. Gregory

Date: 4 MAY 93
County: Grant Parish
State: Louisiana

Do Normal Circumstances exist on the site: ☒ Yes ☐ No
Is the site significantly disturbed (Atypical Situation)? ☐ Yes ☒ No
Is the area a potential Problem Area? ☐ Yes ☒ No
(If needed, explain on reverse.)

Community ID: Upland Forest
Transect ID: _____
Plot ID: 559

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. <u>Pinus taeda</u>	<u>T</u>	<u>FAC</u>	9. <u>Vaccinium arboreum</u>	<u>Sh</u>	<u>FACU</u>
2. <u>Quercus marilandica</u>	<u>T</u>	<u>UPL</u>	10. <u>Witchella repens</u>	<u>H</u>	<u>FACU+</u>
3. <u>Nyssa sylvatica</u>	<u>Shp</u>	<u>FAC</u>	11. _____	_____	_____
4. <u>P. taeda</u>	<u>Shp</u>	<u>FAC</u>	12. _____	_____	_____
5. <u>Smilax albidum</u>	<u>Shp</u>	<u>FACU</u>	13. _____	_____	_____
6. <u>Bignonia capitata</u>	<u>V</u>	<u>FAC</u>	14. _____	_____	_____
7. <u>Vitis rotundifolia</u>	<u>V</u>	<u>FAC</u>	15. _____	_____	_____
8. <u>Smilax rotundifolia</u>	<u>V</u>	<u>FAC</u>	16. _____	_____	_____

Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC): FAC-Neutral = 0%

Remarks: ~80% leaf litter & pine duff; logged - 15 yrs; pine regn. med.

HYDROLOGY

Recorded Data (Describe in Remarks):
☐ Aerial Photographs
☐ Other
☐ No Recorded Data Available

Wetland Hydrology Indicators:

Primary Indicators:

- ☐ Inundated
- ☐ Saturated in Upper 12 Inches
- ☐ Water Marks
- ☐ Drift Lines
- ☐ Sediment Deposits
- ☐ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):

- ☐ Oxidized Root Channels in Upper 12 Inches
- ☐ Water-Stained Leaves
- ☐ Local Soil Survey Data
- ☐ FAC-Neutral Test
- ☐ Other (Explain in Remarks)

Field Observations:

Depth of Surface Water: N/A (n)
Depth to Free Water in Pit: N/A (n)
Depth Saturated Soil: N/A (n)

Remarks: Site is well drained saddle/side slope; no field indicators

SOILS

Map Unit Name Incl: Cadeville Vfsch 5-12%
 (Series and Phase): RK - Rigollette-Kisatchie Assoc.
 Taxonomy (Subgroup): Albaque Hapludalf

Drainage Class: Moderately Well Drained
 Field Observations
 Confirm Mapped Type? ☒ Yes ☐ No

443

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretion, Structure, etc.
0-1	O				leaf/needle litter
1-4	A	10YR 5/2-4/2			sand
4-10	B	10YR 5/4-5/2	5YR 5/8	few fine dist	f. s.
10-18	C	10YR 5/2	2.5YR 4/0	many coarse prom.	C
			10YR 6/8	some med dist.	

Hydric Soil Indicators:

☐ Histosol
☐ Histic Epipedon
☐ Sulfidic Odor
☒ Aquic Moisture Regime
☐ Reducing Conditions
☐ Gleyed

☒ Low-Chroma Colors
☐ Concretions
☐ High Organic Content in Surface Layer in Sandy Soils
☐ Organic Streaking in Sandy Soils
☐ Listed on Local Hydric Soils List
☐ Listed on National Hydric Soils List
☐ Other (Explain in Remarks)

Remarks: Although chroma 2 & mottling, hydric soil indicators are limited and marginal.
Does not fit RK Assoc. very well or any inclusions thereof. Prob. a transitional soil b/t
a Rigollette and Cadeville; drainage is too well established for ponding or aquic moisture regime

WETLAND DETERMINATION

Hydrophytic Vegetation Present? ☐ Yes ☒ No
 Wetland Hydrology Present? ☐ Yes ☒ No
 Hydric Soils Present? ☐ Yes ☒ No

Is this Sampling Point Within a Wetland? ☐ Yes ☒ No

Remarks: Area is typical of nearly level saddles and ridge tops. No indicators found for
wetland criteria.

APPENDIX B
PHOTOGRAPHS

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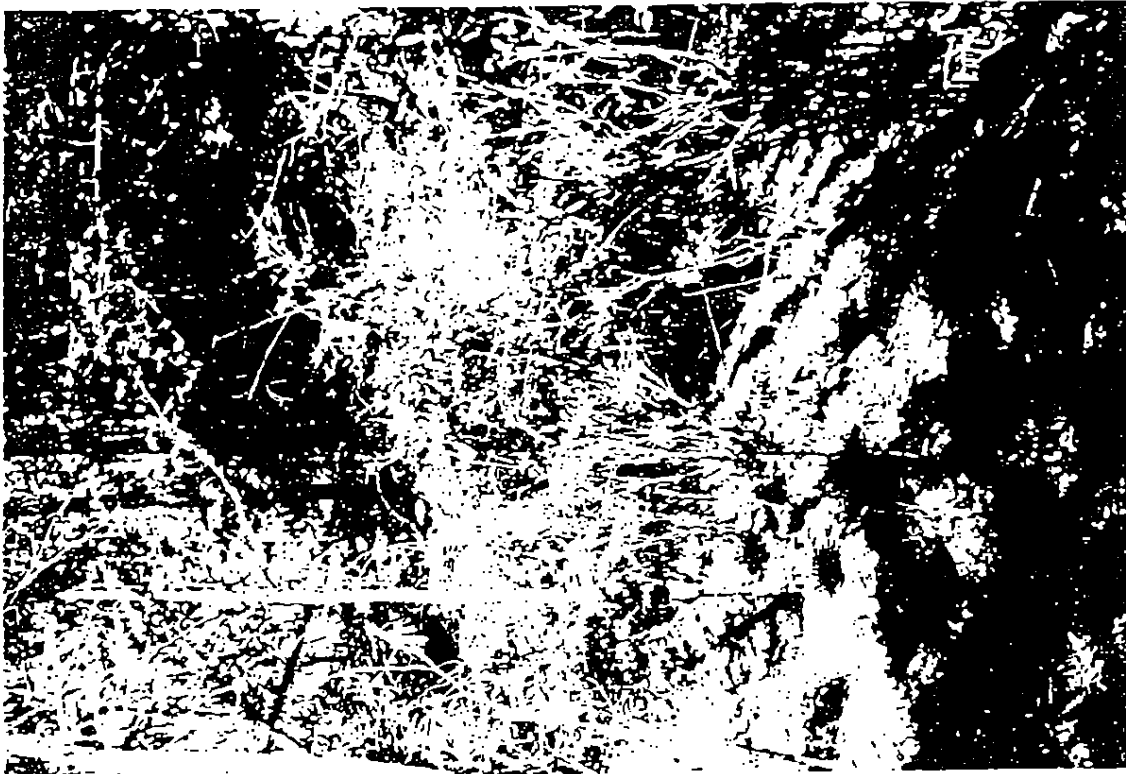
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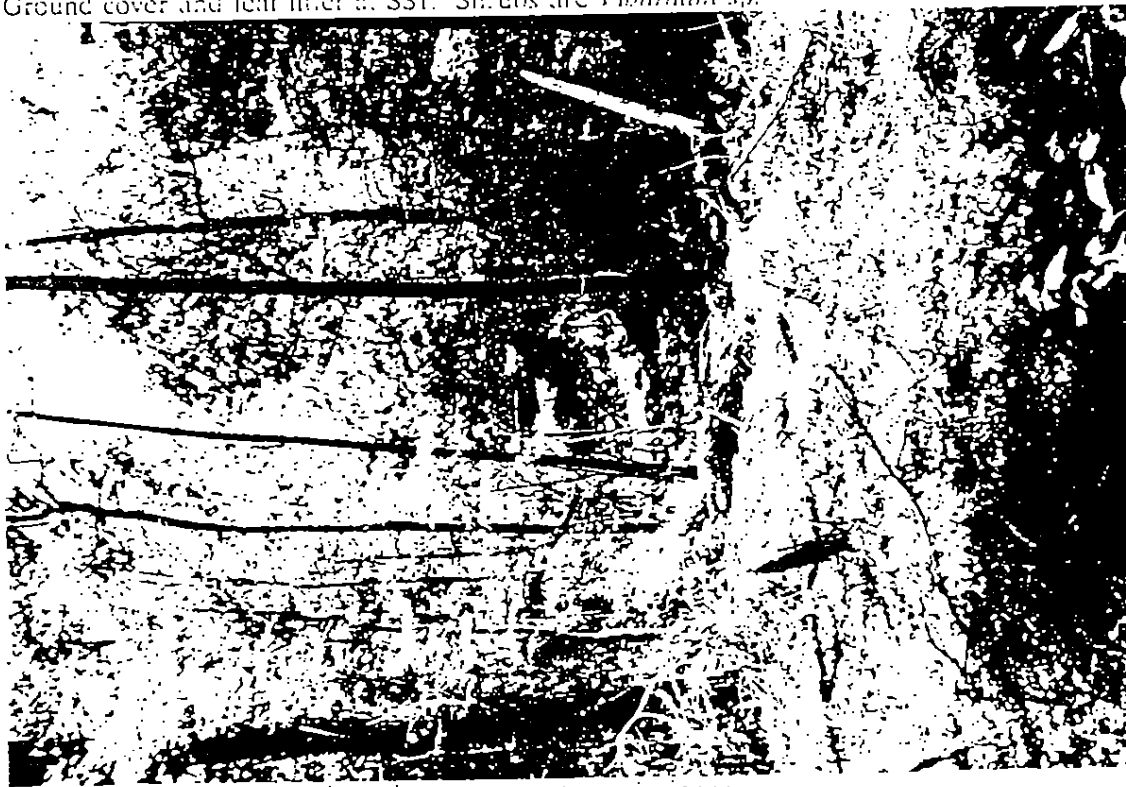
Soil profile at SSI. Soil is a Briley inclusion.



Tree stumps at SSI. Trees are loblolly pine and blackjack oak.



Ground cover and leaf litter at SS1. Shrubs are *Viburnum* sp.



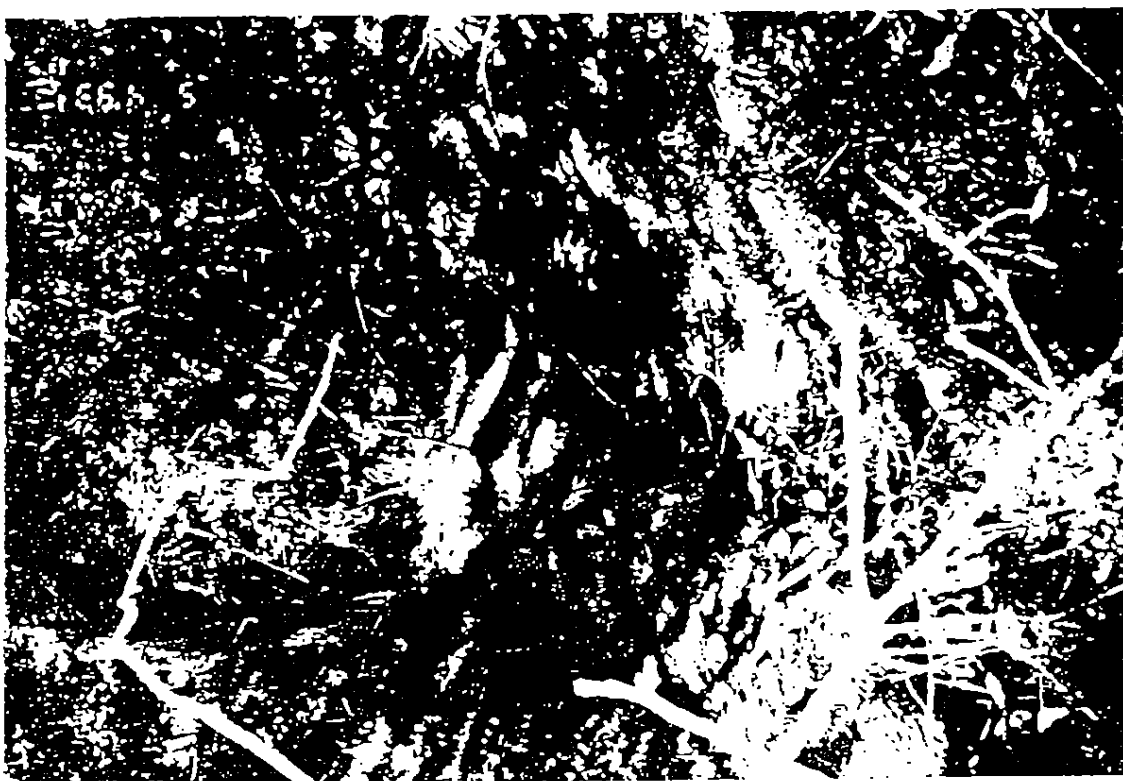
Facing NE along stream boundary across natural drainage



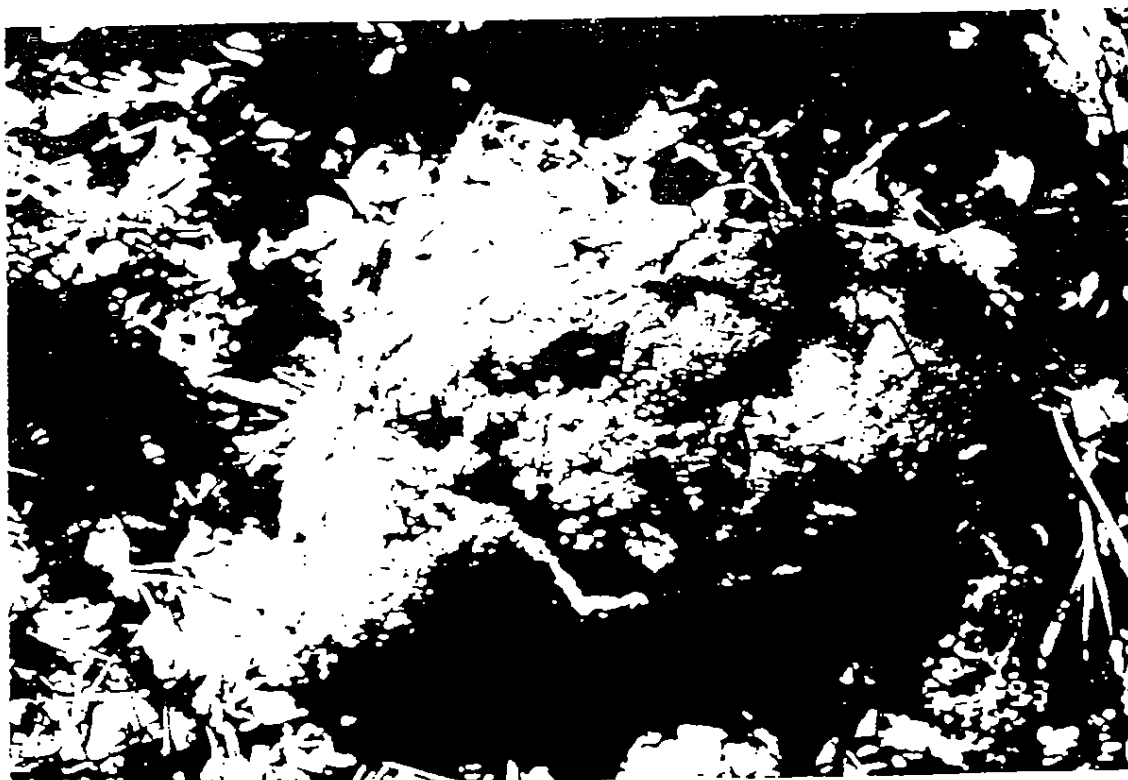
Facing W along drainage near southeast boundary.



Sandstone outcrop along southeast boundary



Natural drainage along northeast boundary.



Soil profile at SS2. Soil is a Ksanthic series.



View upstream along natural drainage near SS2



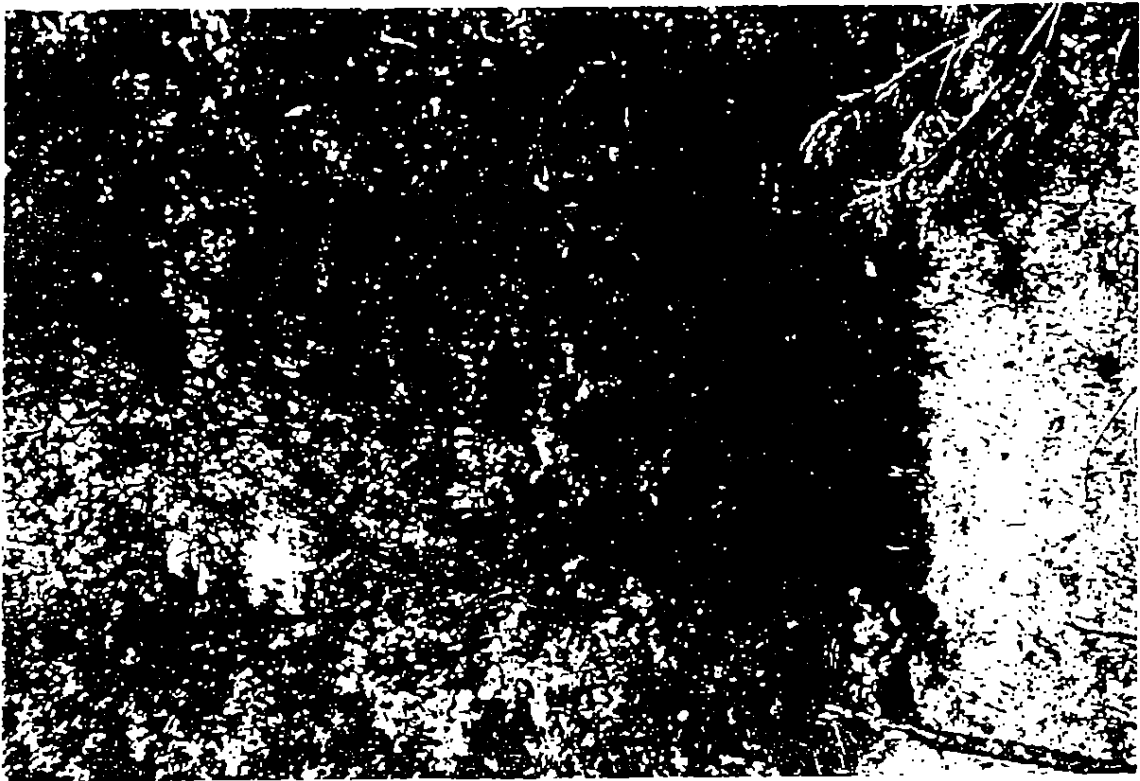
View N of vegetation and ground cover at SS2



EH&A ecologist: excavating soil profile hole at SS3.



Soil profile at SS3. Soil was a Rigolette/Cadeville Intermed.



View N of vegetation near SS3.

APPENDIX 3-B
PRECIPITATION DATA

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MON	YEAR	M MAX	M MIN	M MON	T DEP	HIGH	DAT	LOW	DAT	+90	+32	-32	- 0	PRECIP	P DEP	MAX 24	DAT	.10	.50	1.0
1	1975	64.0	43.0	53.5		80	30	22	13	0	0	5	0	3.74		1.10	8	8	3	1
2	1975	64.2	41.9	53.1		80	23	25	7	0	0	5	0	4.06		1.70	16	5	3	1
3	1975	69.2	47.4	58.3		84	13	33	5	0	0	0	0	6.10		1.35	13	7	5	4
4	1975	73.9	56.1	65.0		87	27	36	3	0	0	0	0	5.53		1.99	9	9	3	2
5	1975	83.3	66.5	74.9		90	28	59	18	2	0	0	0	10.03		3.15	4	10	7	4
6	1975	89.1	70.8	80.0		93	28	60	1	18	0	0	0	3.63		0.85	11	7	3	0
7	1975	90.7	72.4	81.6		96	22	68	12	22	0	0	0	6.54		1.96	10	6	4	3
8	1975	91.1	72.5	81.8		97	29	68	31	22	0	0	0	5.14		1.63	5	8	4	2
9	1975	85.5	63.8	74.7		96	3	47	27	10	0	0	0	2.15		1.49	17	3	1	1
10	1975	80.1	55.4	67.8		90	11	44	31	1	0	0	0	6.84		3.51	16	3	3	2
11	1975	70.6	47.7	59.2		85	10	25	27	0	0	6	0	2.98		1.47	20	6	2	1
12	1975	59.7	39.9	49.8		80	16	21	19	0	0	8	0	2.97		1.52	25	5	1	1
1	1976	59.1	34.5	46.8		76	31	19	8	0	0	15	0	2.13		0.71	25	6	1	0
2	1976	70.0	46.4	58.2		80	20	29	8	0	0	5	0	3.10		1.08	21	4	3	1
3	1976	69.7	51.8	60.8		82	27	37	17	0	0	0	0	8.13		2.33	31	12	6	3
4	1976	79.6	55.7	67.7		87	24	44	1	0	0	0	0	0.74		0.53	30	1	1	0
5	1976	79.8	58.1	69.0		89	23	48	2	0	0	0	0	6.92		2.34	8	6	6	2
6	1976	87.0	66.8	76.9		92	29	58	3	9	0	0	0	10.04		3.99	16	9	4	3
7	1976	90.3	71.4	80.9		96	27	67	19	21	0	0	0	10.50		2.66	18	9	7	5
8	1976	91.8	69.7	80.8		97	27	64	10	25	0	0	0	1.29		0.54	29	3	1	0
9	1976	87.3	66.0	76.7		93	4	55	30	12	0	0	0	3.50		1.33	1	4	3	2
10	1976	73.2	47.1	60.2		87	3	33	21	0	0	0	0	2.24		1.90	30	2	1	1
11	1976	62.6	39.5	51.1		78	27	21	30	0	0	4	0	4.48		1.01	27	7	6	1
12	1976	59.0	36.0	47.5		72	31	26	22	0	0	10	0	5.51		1.99	25	8	4	2
1	1977	49.2	28.8	39.0		71	28	11	10	0	0	22	0	5.48		1.70	9	6	3	3
2	1977	64.8	37.3	51.1		85	26	25	1	0	0	9	0	2.10		0.98	3	6	1	0
3	1977	72.0	49.1	60.6		84	31	35	2	0	0	0	0	8.34		5.01	4	6	4	2
4	1977	77.8	56.7	67.3		84	20	43	6	0	0	0	0	5.66		2.74	21	8	2	2
5	1977	87.0	65.1	76.1		95	31	53	11	7	0	0	0	3.35		3.31	2	1	1	1
6	1977	93.6	70.7	82.2		100	7	58	8	25	0	0	0	1.69		0.92	15	3	2	0
7	1977	94.6	73.6	84.1		100	23	68	6	27	0	0	0	1.09		0.56	6	2	1	0
8	1977	91.5	72.9	82.2		97	1	69	28	22	0	0	0	7.58		1.37	23	15	5	2
9	1977	89.0	70.5	79.8		94	28	64	21	18	0	0	0	3.14		0.78	8	8	3	0
10	1977	79.3	54.4	66.9		93	2	39	13	2	0	0	0	3.68		1.82	24			1
11	1977	68.7	48.9	58.8		81	21	31	11	0	0	1	0	9.65		3.07	2	8	5	5
12	1977	60.5	38.1	49.3		80	5	24	26	0	0	9	0	3.84		1.89	14	6	3	1
1	1978	47.2	30.9	39.1		80	7	22	10	0	3	24	0	6.31		2.02	24	10	5	1
2	1978	52.8	31.5	42.2		73	26	21	22	0	0	17	0	3.90		1.67	1	6	3	2
3	1978	67.2	43.6	55.4		82	16	27	5	0	0	2	0	1.42		0.55	24	4	1	0
4	1978	79.0	55.6	67.3		87	19	44	27	0	0	0	0	0.51		0.40	11	1	0	0
5	1978	85.0	63.8	74.4		93	21	51	5	12	0	0	0	4.54		1.45	7	10	4	1
6	1978	90.6	70.7	80.7		97	30	60	15	18	0	0	0	4.41		3.00	7	4	2	1
7	1978	93.9	71.8	82.9		98	3	65	27	29	0	0	0	6.14		1.35	5	9	5	4
8	1978	91.9	71.5	81.7		97	21	65	21	26	0	0	0	9.36		5.03	29	7	4	4
9	1978	87.8	69.4	78.6		93	4	61	26	14	0	0	0	1.94		0.70	12	5	1	0
10	1978	81.8	52.1	67.0		89	14	37	18	0	0	0	0	0.53		0.32	27	2	0	0
11	1978	72.6	51.2	61.9		86	3	34	9	0	0	0	0	4.93		1.60	27	8	3	2
12	1978	63.0	38.5	50.8		82	4	22	10	0	0	10	0	4.98		1.01	31	8	5	2
1	1979	50.1	32.2	41.2		73	1	12	3	0	1	15	0	11.14		3.60	20	14	6	4
2	1979	55.6	38.7	47.2		76	23	23	10	0	0	10	0	8.70		2.27	24	10	5	4

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MON	YEAR	M MAX	M MIN	M MON	T DEP	HIGH	DAT	LOW	DAT	+90	+32	-32	- 0	PRECIP	P DEP	MAX 24	DAT	.10	.50	1.0
3	1979	71.0	47.7	59.4		82	28	34	25	0	0	0	0	4.16		1.50	3	7	4	1
4	1979	75.9	58.3	67.1		85	26	44	5	0	0	0	0	6.95		2.14	21	11	6	1
5	1979	82.2	61.7	72.0		89	20	49	26	0	0	0	0	2.57		0.85	30	5	2	0
6	1979	89.9	69.8	79.9		96	19	60	13	14	0	0	0	3.15		1.66	2	4	2	1
7	1979	91.3	72.9	82.1		97	5	65	16	22	0	0	0	4.44		1.45	27	9	4	1
8	1979	92.3	72.1	82.2		96	7	65	16	27	0	0	0	3.76		1.00	16	7	4	1
9	1979	86.2	65.2	75.7		94	5	56	16	8	0	0	0	11.88		5.00	21	5	5	3
10	1979	82.4	55.3	68.9		93	2	42	24	3	0	0	0	5.27		3.29	31	2	2	2
11	1979	67.6	40.4	54.0		80	21	24	30	0	0	4	0	6.35		2.37	23	5	4	2
12	1979	61.2	36.9	49.1		77	12	21	18	0	0	11	0	5.92		2.78	13	6	3	3
1	1980	59.5	41.1	50.3		75	12	29	6	0	0	4	0	6.53		3.01	23	6	4	2
2	1980	60.0	36.9	48.5		83	23	21	1	0	0	14	0	4.44		2.79	9	4	2	2
3	1980	68.3	46.3	57.3		81	13	23	3	0	0	3	0	11.03		2.60	28	13	7	5
4	1980	75.2	51.8	63.5		85	23	38	14	0	0	0	0	8.18		3.85	12	7	4	2
5	1980	83.2	63.3	73.3		93	27	52	9	3	0	0	0	3.70		1.38	16	7	2	2
6	1980	92.5	69.9	81.2		100	28	59	10	23	0	0	0	1.53		0.90	23	2	2	0
7	1980	97.8	74.0	85.9		103	17	69	29	29	0	0	0	3.16		1.72	28	4	2	1
8	1980	96.0	72.6	84.3		104	23	64	23	30	0	0	0	1.03		0.96	27	1	1	0
9	1980	93.4	70.5	82.0		99	16	64	28	26	0	0	0	1.27		0.51	6	4	1	0
10	1980	78.7	49.2	64.0		91	5	30	31	3	0	1	0	8.53		6.10	18	3	3	2
11	1980	66.8	43.4	55.1		83	10	29	20	0	0	5	0	4.49		1.45	17	6	5	1
12	1980	61.9	37.2	49.6		79	8	22	21	0	0	12	0	1.75		1.32	9	2	1	1
1	1981	57.7	32.5	45.1		73	30	20	13	0	0	17	0	1.66		0.97	20	2	2	0
2	1981	62.3	37.1	49.7		80	21	14	12	0	0	9	0	3.26		1.65	2	4	2	1
3	1981	70.0	44.5	57.3		85	31	33	20	0	0	0	0	5.90		2.40	30	5	4	2
4	1981	81.6	61.0	71.3		90	30	41	6	1	0	0	0	0.86		0.81	24	1	1	0
5	1981	81.7	60.7	71.2		90	31	48	11	3	0	0	0	5.47		1.64	5	8	4	2
6	1981	90.7	72.3	81.5		96	23	66	28	23	0	0	0	7.12		2.46	6	8	6	3
7	1981	94.2	73.8	84.0		101	24	69	6	25	0	0	0	1.30		0.76	6	3	1	0
8	1981	94.5	71.5	83.0		100	2	65	9	29	0	0	0	5.63		1.59	3	8	4	2
9	1981	88.5	63.8	76.2		94	30	45	19	16	0	0	0	1.64		0.68	15	3	2	0
10	1981	78.1	54.8	66.5		94	2	39	24	4	0	0	0	4.05		1.49	7	8	3	1
11	1981	72.3	47.9	60.1		81	27	29	21	0	0	1	0	3.13		1.08	2	5	3	1
12	1981	59.9	36.6	48.3		79	1	21	19	0	0	7	0	3.84		1.37	14	7	2	2
1	1982	61.2	37.4	49.3		80	22	8	12	0	2	14	0	2.45		0.92	13	5	2	0
2	1982	57.9	38.9	48.4		80	24	26	7	0	0	6	0	5.50		2.88	16	7	3	2
3	1982	71.5	52.1	61.8		87	21	34	8	0	0	0	0	3.31		2.13	31	4	1	1
4	1982	74.2	55.8	65.0		89	6	36	11	0	0	0	0	5.00		2.00	21	6	2	2
5	1982	85.0	63.8	74.4		93	31	48	9	5	0	0	0	1.93		0.59	18	4	3	0
6	1982	90.9	70.0	80.5		97	11	66	17	20	0	0	0	5.43		2.16	21	9	3	1
7	1982	93.8	73.1	83.5		97	24	69	1	30	0	0	0	2.98		0.85	1	7	2	0
8	1982	93.3	72.7	83.0		98	28	70	27	28	0	0	0	5.92		2.00	7	8	5	1
9	1982	88.9	64.2	76.6		97	3	47	23	19	0	0	0	6.19		3.07	12	6	4	2
10	1982	78.5	54.4	66.5		90	10	35	26	3	0	0	0	4.03		1.42	10	5	3	2
11	1982	69.9	48.0	59.0		84	2	32	16	0	0	2	0	9.56		1.62	27	8	7	6
12	1982	65.7	46.3	56.0		82	3	27	13	0	0	2	0	20.80		7.20	26	12	8	4
1	1983	57.0	37.3	47.2	-1.2	75	30	30	24	0	0	6	0	4.79	-0.29	1.41	20	8	5	1
2	1983	60.0	41.4	50.7	-0.9	75	25	32	8	0	0	1	0	8.29	3.63	2.76	1	8	5	4
3	1983	67.8	45.3	56.6	-2.2	82	3	31	11	0	0	1	0	5.69	0.43	2.23	24	5	3	2
4	1983	71.8	51.1	61.5	-5.6	82	30	37	3	0	0	0	0	9.97	5.12	6.90	6	6	2	2

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MON	YEAR	M MAX	M MIN	M MON	T DEP	HIGH	DAT	LOW	DAT	+90	+32	-32	- 0	PRECIP	P DEP	MAX 24	DAT	.10	.50	1.0
5	1983	82.4	61.5	72.0	-1.9	91	30	48	4	3	0	0	0	11.93	6.62	3.40	16	11	6	5
6	1983	86.4	68.7	77.6	-2.5	94	4	59	9	8	0	0	0	4.69	0.80	0.97	22	9	4	0
7	1983	94.3	72.8	83.6	1.1	99	29	63	8	28	0	0	0	2.21	-2.63	1.30	15	2	2	1
8	1983	93.2	73.3	83.3	1.2	98	31	70	5	28	0	0	0	7.99	4.31	2.95	3	6	3	3
9	1983	87.1	64.4	75.8	-1.6	98	1	44	23	12	0	0	0	5.65	1.73	2.61	21	5	4	2
10	1983	80.9	55.7	68.3	1.1	88	5	42	28	0	0	0	0	0.76	-2.99	0.71	22	1	1	0
11	1983	68.8	46.9	57.9	0.4	84	15	29	29	0	0	1	0	7.01	2.65	2.28	23	7	5	3
12	1983	52.2	33.7	43.0	-7.9	77	4	9	26	0	4	12	0	9.02	2.72	2.45	3	11	6	3
1	1984	53.9	32.1	43.0	-5.4	75	7	18	20	0	0	14	0	4.02	-1.06	1.25	10	7	4	1
2	1984	64.6	40.4	52.5	0.9	81	19	23	6	0	0	7	0	9.43	4.77	4.03	12	8	4	3
3	1984	69.9	49.7	59.8	1.0	81	19	31	1	0	0	1	0	3.23	-2.03	1.98	5	7	1	1
4	1984	78.0	54.6	66.3	-0.8	85	25	41	6	0	0	0	0	5.78	0.93	3.25	3	3	2	2
5	1984	85.0	62.7	73.9	0.0	93	15	48	9	7	0	0	0	6.45	1.14	1.89	20	7	6	2
6	1984	89.8	69.4	79.6	-0.5	97	25	51	1	15	0	0	0	8.64	4.75	7.32	7	2	2	2
7	1984	91.7	70.8	81.3	-1.2	96	17	65	31	25	0	0	0	7.55	2.71	2.19	9	7	5	3
8	1984	91.6	70.9	81.3	-0.8	98	20	65	25	24	0	0	0	6.74	3.06	3.30	6	10	3	1
9	1984	87.6	64.9	76.3	-1.1	98	14	50	30	13	0	0	0	4.24	0.32	2.12	23	4	3	1
10	1984	81.7	61.5	71.6	4.4	89	17	40	2	0	0	0	0	11.74	7.99	5.55	21	11	7	3
11	1984	68.0	45.1	56.6	-0.9	86	1	29	24	0	0	4	0	7.80	3.44	2.62	27	5	4	4
12	1984	70.1	49.7	59.9	9.0	81	31	22	7	0	0	2	0	1.69	-4.61	0.60	5	3	2	0
1	1985	53.2	31.2	42.2	-6.2	76	1	13	21	0	1	19	0	3.01	-2.07	0.88	28	7	3	0
2	1985	56.7	37.3	47.0	-4.6	78	22	18	3	0	1	12	0	9.49	4.83	4.85	24	7	5	3
3	1985	73.9	54.3	64.1	5.3	83	11	40	18	0	0	0	0	3.08	-2.18	1.02	1	5	3	1
4	1985	80.1	58.7	69.4	2.3	87	30	43	1	0	0	0	0	1.20	-3.65	0.67	29	4	1	0
5	1985	86.0	63.8	74.9	1.0	91	31	53	4	8	0	0	0	2.91	-2.40	1.77	15	4	2	1
6	1985	92.5	69.7	81.1	1.0	99	17	60	14	24	0	0	0	2.14	-1.75	0.79	28	5	2	0
7	1985	92.6	73.8	83.2	0.3	98	8	70	2					2.70	-2.60	0.80				
8	1985	94.4	72.6	83.5	1.4	100	12	67	26	29	0	0	0	7.46	3.78	3.87	16	7	4	1
9	1985	89.0	65.2	77.1	-0.3	99	5	47	27	17	0	0	0	7.26	3.34	3.80	3	8	3	3
10	1985	80.7	59.5	70.1	2.6	87	15	44	7					1.95	-1.41	1.60				
11	1985	73.2	55.0	64.1	6.6	84	27	40	5	0	0	0	0	3.23	-1.13	1.79	28	6	2	1
12	1985	58.9	34.9	46.9	-4.0	76	10	19	26	0	0	15	0	4.61	-1.69	2.38	12	4	3	2
1	1986	62.7	36.6	49.7	1.3	77	22	25	28	0	0	9	0	1.47	-3.61	0.56	7	4	1	0
2	1986	68.4	45.8	57.1	5.5	85	27	22	12	0	0	3	0	1.59	-3.07	1.05	4	2	1	1
3	1986	73.5	46.6	60.1	1.3	87	30	26	1	0	0	2	0	1.55	-3.71	0.72	12	4	1	0
4	1986	80.3	57.4	68.9	1.8	89	9	45	23	0	0	0	0	2.66	-2.19	1.44	20	3	2	2
5	1986	86.5	65.3	75.9	2.0	93	25	48	4	8	0	0	0	3.57	-1.74	0.72	28	9	3	0
6	1986	91.7	72.2	82.0	1.9	98	28	68	13	26	0	0	0	5.54	1.65	3.05	29	8	2	1
7	1986	95.0	74.0	84.5	2.0	102	31	71	4	30	0	0	0	2.03	-2.81	0.85	18	3	2	0
8	1986	93.3	69.8	81.6	-0.5	103	2	57	30	27	0	0	0	3.67	-0.01	1.85	6	6	2	1
9	1986	90.3	71.3	80.8	3.4	94	28	65	14	23	0	0	0	3.04	-0.88	0.90	3	7	1	0
10	1986	79.3	58.7	69.0	1.8	93	5	44	16	6	0	0	0	5.41	1.66	1.90	13	9	2	2
11	1986	70.2	53.6	61.9	4.4	85	9	33	14	0	0	0	0	8.39	4.03	2.30	25	11	5	3
12	1986	57.1	40.0	48.6	-2.3	76	9	30	29	0	0	3	0	5.92	-0.38	1.90	23	9	4	2
1	1987	55.3	35.0	45.2	-3.2	74	30	23	23	0	0	17	0	4.87	-0.21	2.55	18	5	2	2
2	1987	61.8	44.4	53.1	1.5	77	9	31	10	0	0	1	0	8.31	3.65	1.90	26	12	4	3
3	1987	68.3	46.4	57.4	-1.4	81	21	29	31	0	0	1	0	5.54	0.28	2.90	18	4	3	3
4	1987	79.3	50.1	64.7	-2.4	94	22	33	5	6	0	0	0	0.27	-4.58	0.23	3	1	0	0
5	1987	85.0	66.4	75.7	1.8	91	24	58	1	2	0	0	0	3.29	-2.02	1.57	14	9	1	1
6	1987	89.0	70.6	79.8	-0.3	93	26	61	6	15	0	0	0	3.47	-0.42	1.23	24	7	1	1

11-20-1989

Page 4

MON	YEAR	M MAX	M MIN	M MON	T DEP	HIGH	DAT	LOW	DAT	+90	+32	-32	- 0	PRECIP	P DEP	MAX 24	DAT	.10	.50	1.0
7	1987	91.2	72.2	81.7	-0.8	98	30	67	3	23	0	0	0	4.30	-0.54	1.96	2	6	3	1
8	1987	93.0	74.5	83.8	1.7	98	20	70	31	28	0	0	0	5.89	2.21	2.50	12	7	4	1
9	1987	88.0	65.0	76.5	-0.9	95	10	54	24	12	0	0	0	1.21	-2.71	0.38	17	4	0	0
10	1987	78.4	48.5	63.5	-3.7	87	3	39	13	0	0	0	0	1.30	-2.45	0.80	26	3	1	0
11	1987	70.1	46.2	58.2	0.7	84	5	29	12	0	0	2	0	17.51	13.15	10.02	16	6	6	5
12	1987	63.0	43.4	53.2	2.3	80	15	28	17	0	0	5	0	6.18	-0.12	1.40	7	9	4	3
1	1988	53.5	33.2	43.4	-5.0	73	20	22	11	0	1	16	0	2.66	-2.42	1.14	7	6	2	1
2	1988	61.1	40.8	51.0	-0.6	76	1	21	7	0	0	6	0	4.38	-0.28	0.80	18	8	5	0
3	1988	69.1	48.0	58.6	-0.2	81	29	30	15	0	0	1	0	7.42	2.16	1.78	9	6	6	4
4	1988	78.4	55.4	66.9	-0.2	86	27	39	11	0	0	0	0	1.99	-2.86	1.10	2	5	1	1
5	1988	86.2	59.3	72.8	-1.1	93	18	48	1	10	0	0	0	2.13	-3.18	2.00	22	2	1	1
6	1988	91.1	67.5	79.3	-0.8	98	29	52	11	19	0	0	0	1.86	-2.03	1.22	25	3	1	1
7	1988	90.2	72.9	81.6	-0.9	96	18	69	9	19	0	0	0	4.30	-0.54	1.40	5	10	3	1
8	1988	91.0	73.2	82.1	0.0	97	7	67	31	22	0	0	0	5.22	1.54	1.83	11	8	3	2
9	1988	86.8	68.4	77.6	0.2	91	22	54	8	10	0	0	0	4.23	0.31	2.94	4	3	2	1
10	1988	75.7	53.9	64.8	-2.4	85	19	43	13	0	0	0	0	5.39	1.64	1.75	27	7	4	2
11	1988	71.2	49.6	60.4	2.9	85	9	33	24	0	0	0	0	1.60	-2.76	0.78	13	4	1	0
12	1988	63.2	40.1	51.7	0.8	77	28	26	18	0	0	8	0	6.29	-0.1	1.43	28	10	5	2

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5

ANNUAL CLIMATOLOGICAL SUMMARY

NATIONAL CLIMATIC DATA CENTER
FEDERAL BUILDING
ASHEVILLE, NORTH CAROLINA
28801

STATION IDENTIFICATION

16050098 ALEXANDRIA LOUISIANA ELEVATION 87 FT. ABOVE SEA LEVEL LAT. 31 19N LONG. 92 28W

DATE		TEMPERATURE (° F)										PRECIPITATION (INCHES)												
YR.	MO.	MEAN MAXIMUM	MEAN MINIMUM	MEAN	DEPART. FROM NORMAL	HEATING DEGREE DAYS	COOLING DEGREE DAYS	HIGHEST DATE	LOWEST DATE	NUMBER OF DAYS				TOTAL	DEPART. FROM NORMAL	GREATEST OBSERVED DAY	DATE	SNOW, SLEET			NO. OF DAYS			
										MAX ≥ 90° ≤ 32°	MAX 32° ≤ 32°	MIN 32° ≤ 32°	MIN 32° ≤ 32°					TOTAL FALL	MAX DEPTH	DATE		2.10	2.50	31.0
89	1	63.4	43.8	53.6	5.2	350	5	81	4	27	23*	0	0	3	0	6.27	1.19	.82	12	.0	0	12	5	0
89	2	57.9	40.0	49.0	-2.6	465	24	82	16*	23	7	0	3	11	0	5.06	.40	3.97	21	.07	01	28*	5	1
89	3	68.5	47.4	58.0	-8	264	55	86	31	26	6	0	0	5	0	8.08	2.82	2.25	29	.0	0	6	5	4
89	4	77.1	53.1	65.1	-2.0	95	106	90	30	35	12*	1	0	0	0	1.52	-3.33	.50	28	.0	0	6	1	0
89	5	84.4	65.6	75.0	1.1	0	316	96	29*	54	12*	9	0	0	0	8.03	2.72	2.60	18	.0	0	7	5	3
89	6	86.3	69.8	78.1	-2.0	0	398	94	1	60	16	9	0	0	0	13.56	9.67	3.48	28	.0	0	10	8	7
89	7	90.3	72.4	81.4	-1.1	0	512	95	28*	68	22	20	0	0	0	4.11	-.73	1.06	7	.0	0	10	3	1
89	8	92.0	71.0	81.5	-.6	0	521	98	29*	60	9	26	0	0	0	4.66	.98	1.90	8	.0	0	4	3	2
89	9	87.0	66.4	76.7	-.7	6	362	100	2	51	24	16	0	0	0	.45	-3.47	.23	10	.0	0	2	0	0
89	10	81.4	54.2	67.8	.6	61	155	94	4	30	20	2	0	2	0	.22	-3.53	.15	17	.0	0	1	0	0
89	11	71.8	47.6	59.7	2.2	209	58	87	9*	31	30*	0	0	3	0	2.66	-1.70	1.09	23	.0	0	6	1	1
89	12	52.2	30.2	41.2	-9.7	727	0	76	7	7	23	0	4	17	0	3.38	-2.92	1.70	7	.0	0	1	2	1
ANN.		76.0	55.1	65.6	-.9	2177	2512	100	SEP	7	DEC	83	7	41	0	58.00	2.10	3.97	FEB	.01	0	77	34	20

R MISSING DATA. AN YEARS WITH MONTHLY
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TR.	NO.	MEAN MAXIMUM	MEAN MINIMUM	MEAN	DEPART. FROM NORMAL	HEATING DEGREE DAYS	COOLING DEGREE DAYS	HIGHEST DATE	LOWEST DATE	NUMBER OF DAYS				TOTAL	DEPART. FROM NORMAL	GREATEST OBSERVED DATE	SNOW, SLEET			NO. OF DAYS	
										MAX ≥ 90°	MIN 53° - 90°	MIN 32° - 53°	MIN 32° - 0°				TOTAL FALL	DATE	DATE	DATE	2-10
90	1	62.4	43.2	52.8	4.4	375	3	76 20	29 1	0	5	0	13.95	8.87	3.45	25	.0	0	12	9	7
90	2	67.6	47.0	57.3	5.7	226	17	81 16	34 6*	0	0	0	4.23	-1.43	1.39	22	.0	0	10	1	1
90	3	70.5	51.3	60.9	2.1	180	60	82 10	37 20	0	0	0	6.41	1.15	3.00	15	.0	0	7	3	2
90	4	77.3	55.2	66.3	-1.8	75	117	87 30	38 7	0	0	0	3.27	-1.58	1.48	11	.0	0	7	2	1
90	5	83.6	65.0	74.3	.4	0	297	91 27	55 7*	2	0	0	8.24	2.93	2.60	28	.0	0	8	5	3
90	6	93.8	73.2	83.5	3.4	0	563	101 20	66 24	29	0	0	2.21	-1.68	1.47	1	.0	0	3	2	1
90	7	92.7	71.9	82.3	-2	0	545	99 9	63 15*	23	0	0	2.75	-2.09	.96	4	.0	0		2	0
90	8	95.2	71.9	83.6	1.5	0	584	101 31	60 9	26	0	0	2.24	-1.44	1.20	1	.0	0	5	2	1
90	9	91.0	69.4	80.2	2.8	0	462	101 6*	51 25*	20	0	0	1.66	-2.26	.41	3	.0	0	6	0	0
90	10	79.9	53.4	66.7	-5	97	157	92 9*	40 27*	6	0	0	4.16	.41	3.21	22	.0	0	3	2	1
90	11	72.8	48.1	60.5	3.0	171	40	82 3	33 30	0	0	0	4.15	-1.21	1.22	9	.0	0	4	4	3
90	12	62.3	40.9	51.6	.7	420	12	77 31*	17 25*	0	8	0	7.05	.75	2.55	22	.0	0	11	5	2
SUM.		79.1	57.5	68.3	1.9	1544	2857	01 SEP*	17 DEC	106	0	13	0	60.32	4.42	3.45 JAN	.0	0	81	37	22

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YR.	MO.	MEAN MAXIMUM	MEAN MINIMUM	MEAN	DEPART. FROM NORMAL	HEATING DEGREE DAYS	COOLING DEGREE DAYS	HIGHEST	DATE	LOWEST	DATE	NUMBER OF DAYS				TOTAL	DEPART. FROM NORMAL	GREATEST OBSERVED DAY	SNOW, SLEET		NO. OF DAYS		
												MAX ≥ 90° ≤ 32°	MIN ≤ 32° ≤ 0°	MAX	MIN				TOTAL FALL	MAX DEPTH	DATE	2.10	2.50
91	1	54.1	38.1	46.1	-2.3	580	0	68	7	29	14*	0	6	0	12.13	7.05	2.17	3	.0		12	9	6
91	2	64.4	43.1	53.8	2.2	307	0	73	14*	30	16	0	1	0	5.23	.57	1.57	19	.0	0	8	3	2
91	3	71.1	49.6	60.4	1.6	192	54	85	28	37	30	0	0	0	7.78	2.52	4.00	29	.0	0	4	3	2
91	4	78.6	61.5	70.1	3.0	16	178	86	20*	44	1	0	0	0	14.76	9.91	3.30	29	.0	0	8	6	6
91	5	83.7	68.4	76.1	2.2	0	348	92	28	56	7*	1	0	0	9.64	4.33	2.75	4	.0	0	14	6	2
91	6	90.3	72.2	81.3	1.2	0	494	97	6	68	8	19	0	0	4.54	.65	1.21	23	.0	0	7	4	1
91	7	92.5	73.8	83.2	.7	0	572	97	15	71	18	27	0	0	6.13	1.29	2.23	5	.0	0	5	4	2
91	8	91.1	72.1	81.6	-.5	0	521	96	7*	69	2*	22	0	0	5.88	2.20	2.47	31	.0	0	11	4	1
91	9	86.4	66.8	76.6	-.8	5	358	94	19	52	27	12	0	0	1.83	-2.09	.83	25	.0	0	3	2	0
91	10	81.7	57.8	69.8	2.6	29	185	92	13	44	8	2	0	0	4.65	.90	2.54	30	.0	0	4	3	2
91	11	64.3	42.1	53.2	-4.3	366	20	82	20	25	9	0	5	0	5.95	1.54	2.07	1	.0	0	5	4	2
91	12	63.1	46.6	54.9	4.0	325	19	79	1	34	26*	0	0	0	8.89	2.59	2.50	13	.0	0	9	7	6
ANN.		76.8	57.7	67.3	.8	1820	2749	97	JUL*	25	NOV	83	0	12	0	87.41	31.51	4.00	MAR	0	90	55	32

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U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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DATE	TR.	NO.	MEAN MAXIMUM	MEAN MINIMUM	MEAN	DEPART. FROM NORMAL	HEATING DEGREE DAYS	COOLING DEGREE DAYS	HIGHEST DATE	LOWEST DATE	NUMBER OF DAYS MAX ≥ 90° ≤ 32°	MAX ≤ 32° ≤ 0°	MIN ≤ 32° ≤ 0°	TOTAL	DEPART. FROM NORMAL	GREATEST OBSERVED DAY	SNOW, SLEET		NO. OF DAYS				
																	TOTAL FALL	DATE	DATE	2.10	2.50	21.0	
92	1		56.6	38.1	47.4	-1.0	542	0	69	26	17*	0	7	0	7.31	2.23	1.44		9	6	4		
92	2		65.9	45.3	55.6	4.0	274	7	82	16	33	9	0	0	5.43	.77	.79		9	3	2		
92	3		69.9	50.4	60.2	1.4	154	11	82	16	34	11	0	0	4.13	-1.13	1.07		6	3	1		
92	4		76.1	55.6	65.9	-1.2	70	102	88	25	41	3	0	0	3.31	-1.54	.69		6	5	0		
92	5		82.8	62.8	72.8	-1.1	14	264	92	15	48	8*	2	0	2.58	-2.73	1.14		5	2	1		
92	6		88.8	70.8	79.8	-.3	0	450	97	20	62	1	15	0	9.14	5.25	5.35		11	4	1		
92	7		92.3	73.7	83.0	.5	0	566	97	8*	70	19*	27	0	3.53	-1.31	1.10		7	2	1		
92	8		88.5	69.8	79.2	-2.9	0	446	95	8	62	29*	14	0	3.75	.07	1.12		5	2	2		
92	9		86.5	67.9	77.2	-.2	0	375	93	11	51	30	11	0	4.03	.11	2.15		3	3	2		
92	10		75.8	55.8	67.8	.6	16	109	86	27	48	19*	0	0	2.50	-1.25	1.33		4	3	1		
92	11		63.7M	44.5	54.1M	-3.4	333B	178	83	1	28	29	0	2	6.70	2.34	1.82		10	6	3		
92	12		60.1	43.3	51.7	.8	410	1	74	31	30	1	0	1	5.84	-.46	1.46		8	5	3		
ANN.			75.9M	56.5	66.2M	-.2	1813B	2348B	97	JUL*	25	JAN	69	0	10	58.25	2.35	5 05	JUN		83	44	21

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Header Definitions:

MON -- month

M MAX -- mean monthly maximum temperature

M MIN -- mean monthly minimum temperature

M MON -- mean monthly average daily temperature

T DEP -- temperature departure of the mean monthly daily
temperature from the 30-year normal (if available)

HIGH/DAT -- highest maximum temperature recorded during the
month and the date of occurrence

LOW/DAT -- lowest minimum temperature recorded during the
month and the date of occurrence

+90 -- number of days with maximums $\geq 90^{\circ}\text{F}$

+32 -- number of days with maximums $\leq 32^{\circ}\text{F}$

-32 -- number of days with minimums $\leq 32^{\circ}\text{F}$

-0 -- number of days with minimums $\leq 0^{\circ}\text{F}$

PRECIP -- total monthly precipitation

P DEP -- monthly precipitation departure from the 30-year
normal (if available)

MAX 24/DAT -- maximum precipitation accumulated in a single
day and the date of occurrence

.10 -- number of days with precipitation $\geq 0.10''$

.50 -- number of days with precipitation $\geq 0.50''$

1.0 -- number of days with precipitation $\geq 1.00''$

APPENDIX 3-C

STREAM INFLUENT METALS CONCENTRATION CALCULATIONS

METAL DEPOSITION RATE

ALUMINUM

GRID POINT	MODELED ANNUAL DEP RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (g/sec)	METAL DEP RATE (g/m ²)
A1	3500	194.44	9.72	6.48	62.99
A4	1600	88.89	4.44	6.48	28.77
B1	9120	506.67	25.33	6.48	164.14
B4	2470	137.22	6.86	6.48	44.45
B2	9800	544.44	27.22	6.48	176.39
B3	9000	500.00	25.00	6.48	162.00
C2	7300	405.56	20.28	6.48	131.41
C3	5500	305.56	15.28	6.48	99.01

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- 1 g/sec / unitized deposition rate = metal emission rate, g/sec / metal deposition rate, g/m²
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

ALUMINUM

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	75.11	8044	604,185	-
B2/B3/C2/C3	142.21	5060	719,583	-
TOTAL	-	-	1,323,768	1,059,014

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

METAL DEPOSITION RATE

ANTIMONY

GRID POINT	MODELED ANNUAL DEP RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (x10 ⁻² g/sec)	METAL DEP RATE (x10 ⁻² g/m ²)
A1	3500	194.44	9.72	8.64	84.0
A4	1600	88.89	4.44	8.64	38.4
B1	9120	506.67	25.33	8.64	218.9
B4	2470	137.22	6.86	8.64	59.3
B2	9800	544.44	27.22	8.64	235.2
B3	9000	500.00	25.00	8.64	216.0
C2	7300	405.56	20.28	8.64	175.2
C3	5500	305.56	15.28	8.64	132.0

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- 1 g/sec / unitized deposition rate = metal emission rate, g/sec / metal deposition rate, g/m²
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

ANTIMONY

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	1.000	8044	8,044	-
B2/B3/C2/C3	1.900	5060	9,614	-
TOTAL	-	-	17,658	14,126

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

METAL DEPOSITION RATE

BARIUM

GRID POINT	MODELED ANNUAL DEP RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (g/sec)	METAL DEP RATE (g/m ²)
A1	3500	194.44	9.72	5.18	50.35
A4	1600	88.89	4.44	5.18	23.00
B1	9120	506.67	25.33	5.18	131.21
B4	2470	137.22	6.86	5.18	35.53
B2	9800	544.44	27.22	5.18	141.00
B3	9000	500.00	25.00	5.18	129.50
C2	7300	405.56	20.28	5.18	105.05
C3	5500	305.56	15.28	5.18	79.15

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- $1 \text{ g/sec} / \text{unitized deposition rate} = \text{metal emission rate, g/sec} / \text{metal deposition rate, g/m}^2$
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

BARIUM

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	60.03	8044	482,881	-
B2/B3/C2/C3	113.68	5060	575,221	-
TOTAL	-	-	1,058,102	846,482

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

METAL DEPOSITION RATE

BERYLLIUM

GRID POINT	MODELED ANNUAL DEP. RATE (g/m ²)	MODELED DEP. RATE (g/m ²)	UNITIZED DEP. RATE (g/m ²)	EMISSION RATE (x10 ⁻⁴ g/sec)	METAL DEP. RATE (x10 ⁻⁴ g/m ²)
A1	3500	194.44	9.72	8.64	84.0
A4	1600	88.89	4.44	8.64	38.4
B1	9120	506.67	25.33	8.64	218.9
B4	2470	137.22	6.86	8.64	59.3
B2	9800	544.44	27.22	8.64	235.2
B3	9000	500.00	25.00	8.64	216.0
C2	7300	405.56	20.28	8.64	175.2
C3	5500	305.56	15.28	8.64	132.0

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- 1 g/sec / unitized deposition rate = metal emission rate, g/sec / metal deposition rate, g/m²
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

BERYLLIUM

GRID AREA	AVERAGE DEP. RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	0.010	8044	80	-
B2/B3/C2/C3	0.0189	5060	96	-
TOTAL	-	-	176	141

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

METAL DEPOSITION RATE

CHROMIUM

GRID POINT	MODELED ANNUAL DEP RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (x10 ⁻⁴ g/sec)	METAL DEP RATE (x10 ⁻⁴ g/m ²)
A1	3500	194.44	9.72	6.05	58.8
A4	1600	88.89	4.44	6.05	26.9
B1	9120	506.67	25.33	6.05	153.2
B4	2470	137.22	6.86	6.05	41.5
B2	9800	544.44	27.22	6.05	164.7
B3	9000	500.00	25.00	6.05	151.3
C2	7300	405.56	20.28	6.05	122.7
C3	5500	305.56	15.28	6.05	92.4

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- 1 g/sec / unitized deposition rate = metal emission rate. g/sec / metal deposition rate. g/m²
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

CHROMIUM

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	0.0070	8044	56	-
B2/B3/C2/C3	0.0132	5060	67	-
TOTAL	-	-	123	98

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

METAL DEPOSITION RATE

COPPER

GRID POINT	MODELED ANNUAL DEP RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (x10 ⁻² g/sec)	METAL DEP RATE (x10 ⁻² g/m ²)
A1	3500	194.44	9.72	8.64	84.0
A4	1600	88.89	4.44	8.64	38.4
B1	9120	506.67	25.33	8.64	218.9
B4	2470	137.22	6.86	8.64	59.3
B2	9800	544.44	27.22	8.64	235.2
B3	9000	500.00	25.00	8.64	216.0
C2	7300	405.56	20.28	8.64	175.2
C3	5500	305.56	15.28	8.64	132.0

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- 1 g/sec / unitized deposition rate = metal emission rate, g/sec / metal deposition rate, g/m²
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

COPPER

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUN-OFF @ 80% (g)
A1/A4/B1/B4	1.000	8044	8.044	-
B2/B3/C2/C3	1.900	5060	9.614	-
TOTAL	-	-	17.658	14.126

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

METAL DEPOSITION RATE

LEAD

GRID POINT	MODELED ANNUAL DEP RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (g/sec)	METAL DEP RATE (g/m ²)
A1	3500	194.44	9.72	0.803	7.81
A4	1600	88.89	4.44	0.803	3.57
B1	9120	506.67	25.33	0.803	20.34
B4	2470	137.22	6.86	0.803	5.51
B2	9800	544.44	27.22	0.803	21.86
B3	9000	500.00	25.00	0.803	20.08
C2	7300	405.56	20.28	0.803	16.28
C3	5500	305.56	15.28	0.803	12.27

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- $1 \text{ g/sec} / \text{unitized deposition rate} = \text{metal emission rate, g/sec} / \text{metal deposition rate, g/m}^2$
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

LEAD

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	9.31	8044	74,890	-
B2/B3/C2/C3	17.62	5060	89,157	-
TOTAL	-	-	164,047	131,238

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

METAL DEPOSITION RATE

MERCURY

GRID POINT	MODELED ANNUAL DEP RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (g/sec)	METAL DEP RATE (g/m ²)
A1	3500	194.44	9.72	0.250	2.43
A4	1600	88.89	4.44	0.250	1.11
B1	9120	506.67	25.33	0.250	6.33
B4	2470	137.22	6.86	0.250	1.72
B2	9800	544.44	27.22	0.250	6.81
B3	9000	500.00	25.00	0.250	6.25
C2	7300	405.56	20.28	0.250	5.07
C3	5500	305.56	15.28	0.250	3.82

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- $1 \text{ g/sec} / \text{unitized deposition rate} = \text{metal emission rate, g/sec} / \text{metal deposition rate, g/m}^2$
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

MERCURY

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	2.90	8044	23,328	-
B2/B3/C2/C3	5.49	5060	27,779	-
TOTAL	-	-	51,107	40,886

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.
- Mercury was assumed to have a 100% mass emission rate.

METAL DEPOSITION RATE

NICKEL

GRID POINT	MODELED ANNUAL DEP RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (x10 ⁻² g/sec)	METAL DEP RATE (x10 ⁻² g/m ²)
A1	3500	194.44	9.72	9.50	92.34
A4	1600	88.89	4.44	9.50	42.18
B1	9120	506.67	25.33	9.50	240.64
B4	2470	137.22	6.86	9.50	65.17
B2	9800	544.44	27.22	9.50	258.59
B3	9000	500.00	25.00	9.50	237.50
C2	7300	405.56	20.28	9.50	192.66
C3	5500	305.56	15.28	9.50	145.16

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- 1 g/sec / unitized deposition rate = metal emission rate, g/sec / metal deposition rate, g/m²
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

NICKEL

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	1.10	8044	8.848	-
B2/B3/C2/C3	2.09	5060	10.575	-
TOTAL	-	-	19.423	15,538

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

METAL DEPOSITION RATE

SELENIUM

GRID POINT	MODELED ANNUAL DEP RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (g/sec)	METAL DEP RATE (g/m ²)
A1	3500	194.44	9.72	2.59	25.17
A4	1600	88.89	4.44	2.59	11.50
B1	9120	506.67	25.33	2.59	65.60
B4	2470	137.22	6.86	2.59	17.77
B2	9800	544.44	27.22	2.59	70.50
B3	9000	500.00	25.00	2.59	64.75
C2	7300	405.56	20.28	2.59	52.53
C3	5500	305.56	15.28	2.59	39.58

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- $1 \text{ g/sec} / \text{unitized deposition rate} = \text{metal emission rate, g/sec} / \text{metal deposition rate, g/m}^2$
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

SELENIUM

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	30.02	8044	241,481	-
B2/B3/C2/C3	56.34	5060	287,610	-
TOTAL	-	-	529,091	423,273

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

METAL DEPOSITION RATE

ZINC

GRID POINT	MODELED ANNUAL DEP. RATE (g/m ²)	MODELED DEP RATE (g/m ²)	UNITIZED DEP RATE (g/m ²)	EMISSION RATE (x10 ⁻² g/sec)	METAL DEP RATE (x10 ⁻² g/m ²)
A1	3500	194.44	9.72	8.64	84.0
A4	1600	88.89	4.44	8.64	38.4
B1	9120	506.67	25.33	8.64	218.9
B4	2470	137.22	6.86	8.64	59.3
B2	9800	544.44	27.22	8.64	235.2
B3	9000	500.00	25.00	8.64	216.0
C2	7300	405.56	20.28	8.64	175.2
C3	5500	305.56	15.28	8.64	132.0

Notes:

- Divide all modeled deposition rates by 20 to obtain 1 g/s unitized deposition rate.
- 1 g/sec / unitized deposition rate = metal emission rate, g/sec / metal deposition rate, g/m²
- The modeled deposition rate represents a 20 day period

TOTAL METAL DEPOSITION

ZINC

GRID AREA	AVERAGE DEP RATE (g/m ²)	SURFACE AREA (m ²)	TOTAL METAL DEPOSITION (g)	TOTAL METAL RUNOFF @ 80% (g)
A1/A4/B1/B4	1.000	8044	8,044	-
B2/B3/C2/C3	1.900	5060	9,614	-
TOTAL	-	-	17,658	14,126

Notes:

- Average deposition rate determined by averaging four values from each grid point.
- Surface area A1/A4/B1/B4 represents the thermal treatment pad area minus the contained area of the 20 treatment units.

STREAM INFLUENT METAL CONCENTRATIONS

PARAMETER	TOTAL METAL DISCHARGED (g)	METAL DISCHARGE CONCENTRATION (mg/L)	STREAM INFLUENT CONCENTRATION (mg/L)
ALUMINUM	1,059,014	3,084.99	1,028.33
BARIUM	846,482	2,465.86	821.95
BERYLLIUM	141	0.41	0.14
CHROMIUM	98	0.29	0.10
COPPER	14,126	41.15	13.72
MERCURY	40,886	119.10	39.70
NICKEL	15,538	45.26	15.09
LEAD	131,238	382.31	127.44
ANTIMONY	14,126	41.15	13.72
SELENIUM	423,273	1,233.03	411.01
ZINC	14,126	41.15	13.72

APPENDIX 3-D
TR-55 HYDROGRAPHS


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      Executed: 02-03-1994 16:04:05
Watershed file: --> c:\pondpack\R-DPAD2 .WSD
Hydrograph file: --> c:\pondpack\R-DPAD2 .HYD

```

>>>> Input Parameters Used to Compute Hydrograph <<<<

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 3.30 acres or 0.00516 sq.mi
Peak discharge = 1 cfs

Subarea Description	Input Values		Rounded Values		Ia/p	Ia/p Messages
	Tc (hr)	* Tt (hr)	Tc (hr)	* Tt (hr)	Interpolated (Yes/No)	
AREA NO. 1	0.10	0.97	0.10	1.00	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.

TR-55 TABULAR HYDROGRAPH METHOD
Type III Distribution
(24 hr. Duration Storm)

Executed: 02-03-1994 16:04:05
Watershed file: --> c:\pondpack\R-DPAD2 .WSD
Hydrograph file: --> c:\pondpack\R-DPAD2 .HYD

CALCULATE THE HYDROGRAPH DUE TO RUNOFF FROM THE POND AND PAD AT
THE OUTFALL OF THE ENTIRE AREA OF CONCERN

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
----- AREA NO. 1 -----	----- 1 -----	----- 12.7 -----
Composite Watershed	1	12.7

TR-55 TABULAR HYDROGRAPH METHOD
Type III Distribution
(24 hr. Duration Storm)

Executed: 02-03-1994 16:04:05
Watershed file: --> c:\pondpack\R-DPAD2 .WSD
Hydrograph file: --> c:\pondpack\R-DPAD2 .HYD

CALCULATE THE HYDROGRAPH DUE TO RUNOFF FROM THE POND AND PAD AT
THE OUTFALL OF THE ENTIRE AREA OF CONCERN

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
AREA NO. 1	0	0	0	0	0	0	0	0	0
Total (cfs)	0	0	0	0	0	0	0	0	0

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
AREA NO. 1	0	0	1	1	1	1	1	1	1
Total (cfs)	0	0	1	1	1	1	1	1	1

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
AREA NO. 1	0	0	0	0	0	0	0	0	0
Total (cfs)	0	0	0	0	0	0	0	0	0

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
AREA NO. 1	0	0	0	0	0
Total (cfs)	0	0	0	0	0

TR-55 TABULAR HYDROGRAPH METHOD
Type III Distribution
(24 hr. Duration Storm)

Executed: 02-03-1994 16:04:05
Watershed file: --> c:\pondpack\R-DPAD2 .WSD
Hydrograph file: --> c:\pondpack\R-DPAD2 .HYD

CALCULATE THE HYDROGRAPH DUE TO RUNOFF FROM THE POND AND PAD AT
THE OUTFALL OF THE ENTIRE AREA OF CONCERN

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	0	14.8	0
11.1	0	14.9	0
11.2	0	15.0	0
11.3	0	15.1	0
11.4	0	15.2	0
11.5	0	15.3	0
11.6	0	15.4	0
11.7	0	15.5	0
11.8	0	15.6	0
11.9	0	15.7	0
12.0	0	15.8	0
12.1	0	15.9	0
12.2	0	16.0	0
12.3	0	16.1	0
12.4	0	16.2	0
12.5	0	16.3	0
12.6	0	16.4	0
12.7	1	16.5	0
12.8	1	16.6	0
12.9	1	16.7	0
13.0	1	16.8	0
13.1	1	16.9	0
13.2	1	17.0	0
13.3	1	17.1	0
13.4	1	17.2	0
13.5	1	17.3	0
13.6	1	17.4	0
13.7	1	17.5	0
13.8	1	17.6	0
13.9	0	17.7	0
14.0	0	17.8	0
14.1	0	17.9	0
14.2	0	18.0	0
14.3	0	18.1	0
14.4	0	18.2	0
14.5	0	18.3	0
14.6	0	18.4	0

14.7

0

18.5

0



TR-55 TABULAR HYDROGRAPH METHOD
Type III Distribution
(24 hr. Duration Storm)

Executed: 02-03-1994 16:04:05
Watershed file: --> c:\pondpack\R-DPAD2 .WSD
Hydrograph file: --> c:\pondpack\R-DPAD2 .HYD

CALCULATE THE HYDROGRAPH DUE TO RUNOFF FROM THE POND AND PAD AT
THE OUTFALL OF THE ENTIRE AREA OF CONCERN

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	0	22.4	0
18.7	0	22.5	0
18.8	0	22.6	0
18.9	0	22.7	0
19.0	0	22.8	0
19.1	0	22.9	0
19.2	0	23.0	0
19.3	0	23.1	0
19.4	0	23.2	0
19.5	0	23.3	0
19.6	0	23.4	0
19.7	0	23.5	0
19.8	0	23.6	0
19.9	0	23.7	0
20.0	0	23.8	0
20.1	0	23.9	0
20.2	0	24.0	0
20.3	0	24.1	0
20.4	0	24.2	0
20.5	0	24.3	0
20.6	0	24.4	0
20.7	0	24.5	0
20.8	0	24.6	0
20.9	0	24.7	0
21.0	0	24.8	0
21.1	0	24.9	0
21.2	0	25.0	0
21.3	0	25.1	0
21.4	0	25.2	0
21.5	0	25.3	0
21.6	0	25.4	0
21.7	0	25.5	0
21.8	0	25.6	0
21.9	0	25.7	0
22.0	0	25.8	0
22.1	0	25.9	0
22.2	0		
22.3	0		

TR-55 TABULAR HYDROGRAPH METHOD
Type III Distribution
(24 hr. Duration Storm)

Executed: 02-03-1994 16:01:57
Watershed file: --> c:\pondpack\R-DPAD .WSD
Hydrograph file: --> c:\pondpack\R-DPAD .HYD

RUNOFF CALCULATION TO DETERMINE THE CONCENTRATIONS OF
PARTICULATES WASHED FROM THE PAD

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
AREA NO. 1	397.00	75.0	1.25	0.00	1.00	0.03	.67 .50

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 397.00 acres or 0.6203 sq.mi
Peak discharge = 3 cfs

>>>> Computer Modifications of Input Parameters <<<<

Subarea Description	Input Values		Rounded Values		Ia/p Interpolated	Ia/p Messages
	Tc (hr)	* Tt (hr)	Tc (hr)	* Tt (hr)	(Yes/No)	
AREA NO. 1	1.33	0.00	1.25	0.00	No	Computed Ia/p > .5

* Travel time from subarea outfall to composite watershed outfall point.

TR-55 TABULAR HYDROGRAPH METHOD
Type III Distribution
(24 hr. Duration Storm)

Executed: 02-03-1994 16:01:57
Watershed file: --> c:\pondpack\R-DPAD .WSD
Hydrograph file: --> c:\pondpack\R-DPAD .HYD

RUNOFF CALCULATION TO DETERMINE THE CONCENTRATIONS OF
PARTICULATES WASHED FROM THE PAD

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
----- AREA NO. 1 -----	----- 3 -----	----- 13.4 -----
Composite Watershed	3	13.4

TR-55 TABULAR HYDROGRAPH METHOD
Type III Distribution
(24 hr. Duration Storm)

Executed: 02-03-1994 16:01:57
Watershed file: --> c:\pondpack\R-DPAD .WSD
Hydrograph file: --> c:\pondpack\R-DPAD .HYD

RUNOFF CALCULATION TO DETERMINE THE CONCENTRATIONS OF
PARTICULATES WASHED FROM THE PAD

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
AREA NO. 1	0	0	0	0	0	0	0	0	0
Total (cfs)	0	0	0	0	0	0	0	0	0

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
AREA NO. 1	0	0	1	1	2	2	3	2	2
Total (cfs)	0	0	1	1	2	2	3	2	2

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
AREA NO. 1	2	2	2	2	1	1	1	1	1
Total (cfs)	2	2	2	2	1	1	1	1	1

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
AREA NO. 1	1	1	1	1	0
Total (cfs)	1	1	1	1	0

TR-55 TABULAR HYDROGRAPH METHOD
Type III Distribution
(24 hr. Duration Storm)

Executed: 02-03-1994 16:01:57
Watershed file: --> c:\pondpack\R-DPAD .WSD
Hydrograph file: --> c:\pondpack\R-DPAD .HYD

RUNOFF CALCULATION TO DETERMINE THE CONCENTRATIONS OF
PARTICULATES WASHED FROM THE PAD

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	0	14.8	2
11.1	0	14.9	2
11.2	0	15.0	2
11.3	0	15.1	2
11.4	0	15.2	2
11.5	0	15.3	1
11.6	0	15.4	1
11.7	0	15.5	1
11.8	0	15.6	1
11.9	0	15.7	1
12.0	0	15.8	1
12.1	0	15.9	1
12.2	0	16.0	1
12.3	0	16.1	1
12.4	0	16.2	1
12.5	0	16.3	1
12.6	0	16.4	1
12.7	1	16.5	1
12.8	1	16.6	1
12.9	2	16.7	1
13.0	2	16.8	1
13.1	2	16.9	1
13.2	2	17.0	1
13.3	2	17.1	1
13.4	3	17.2	1
13.5	3	17.3	1
13.6	2	17.4	1
13.7	2	17.5	1
13.8	2	17.6	1
13.9	2	17.7	1
14.0	2	17.8	1
14.1	2	17.9	1
14.2	2	18.0	1
14.3	2	18.1	1
14.4	2	18.2	1
14.5	2	18.3	1
14.6	2	18.4	1

14.7

2

18.5

1



TR-55 TABULAR HYDROGRAPH METHOD
Type III Distribution
(24 hr. Duration Storm)

Executed: 02-03-1994 16:01:57
Watershed file: --> c:\pondpack\R-DPAD .WSD
Hydrograph file: --> c:\pondpack\R-DPAD .HYD

RUNOFF CALCULATION TO DETERMINE THE CONCENTRATIONS OF
PARTICULATES WASHED FROM THE PAD

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	1	22.4	1
18.7	1	22.5	1
18.8	1	22.6	1
18.9	1	22.7	1
19.0	1	22.8	1
19.1	1	22.9	1
19.2	1	23.0	1
19.3	1	23.1	1
19.4	1	23.2	1
19.5	1	23.3	1
19.6	1	23.4	1
19.7	1	23.5	1
19.8	1	23.6	1
19.9	1	23.7	1
20.0	1	23.8	1
20.1	1	23.9	1
20.2	1	24.0	0
20.3	1	24.1	0
20.4	1	24.2	0
20.5	1	24.3	0
20.6	1	24.4	0
20.7	1	24.5	0
20.8	1	24.6	0
20.9	1	24.7	0
21.0	1	24.8	0
21.1	1	24.9	0
21.2	1	25.0	0
21.3	1	25.1	0
21.4	1	25.2	0
21.5	1	25.3	0
21.6	1	25.4	0
21.7	1	25.5	0
21.8	1	25.6	0
21.9	1	25.7	0
22.0	1	25.8	0
22.1	1	25.9	0
22.2	1		
22.3	1		

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for the following Pages

5

By JDW Date 2/3/94
Chkd. by RJR Date 2/3/94
Subject R&D



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ETE Division

Consulting Engineers, Surveyors & Hydrogeologists

Job No. 16-30912
Sheet No. 1 of 5

Calculation of Hydrograph to determine concentrations of wastes in the run off

Point of Concern was taken at Highway 471 where Summerfield branch crosses. This point will give us a point to check the concentrations before the run off reaches a permanent stream.

Soil is a Rigolette-Kisatchie association hilly

(23)

Description is found in Appendix 5 of the Part B permit Application

Sandy soil

Soil Type C

Runoff is Rapid

Woods are in fair condition

CN = 73

Also some Caddo silt loam

Soil Type D

(10)

CN = 79

Note: the extent of these soil types had to be assumed.

Also some Gore silt loam

Soil Type

(57)

CN = 79

Area by Planimeter

Total = 400 Ac - 3.3 Ac = 397 Ac

(10) = 42

(57) = 34

(23) = 321 Ac

Area of Pond and Slab

Soil has characteristic rapid run off

First we find CN

$$\frac{(73)(321 \text{ Ac}) + (79)(42) + (79)(34)}{397 \text{ Ac}}$$

CN_{WT} = 74.1 Use CN = 75

By J.D.W. Date 2/3/94Chkd by RJA Date 2/3/94Subject R80**ViroGroup**

ETE Division

Consulting Engineers, Surveyors & Hydrogeologists

Job No. 16-30912Sheet No. 2 of 5Use the following Equations to solve for t_c

$$t_L = \frac{L^{0.9} (S+1)^{0.7}}{1900 Y^{0.5}}$$

$$t_L = 0.6 t_c$$

$$S = \frac{1000}{CN} - 10$$

 L = hydraulic length in feet Y = average land slope in percent(Equations from Chapter 2 of
Applied Hydrology and Sedimentology
for Disturbed Areas by Barfield,
Warner and Haan)

$$L = 5600'$$

$$S = \frac{1000}{75} - 10 \quad S = 3.33$$

 Y is calculated using the grid Method illustrated on the
attached copy

$$\begin{aligned} \text{Vertical Intersections} &= 184 \\ \text{Length} &= 56,800 \end{aligned}$$

$$\begin{aligned} \text{Horizontal Intersections} &= 166 \\ \text{Length} &= 57,400' \end{aligned}$$

$$\text{Contour Interval} = 10'$$

$$S_v = \frac{(184)(10)}{56,800} = 0.032$$

$$S_h = \frac{(166)(10)}{57,400} = 0.029$$

$$Y = \frac{0.032 + 0.029}{2} \times 100\% = 3.05\%$$

$$t_L = \frac{(5600)^{0.9} (3.33+1)^{0.7}}{1900 (3.05)^{0.5}} = \frac{(1996.7)(2.8)}{3,318.2}$$

$$t_L = 0.8 \text{ hr}$$

$$t_L = 0.6 t_c$$

$$t_c = \frac{0.8}{0.6}$$

$$t_c = 1.33 \text{ hr}$$

By J.D.W. Date 2/3/94

Chkd. by Rjt Date 2/3/94



ETE Division

Consulting Engineers, Surveyors & Hydrogeologists

Job No. 16-30912

Sheet No. 3 of 5

Subject _____

Input data into QTR55 Program

Area = 397 Ac

CN = 75

$t_c = 1.33$ hr

$P = 1''$ based on analysis of actual rainfall data.
This P represents that it usually rains $1''$ in a day at least once every 20 days

SCS Distribution III

See Attached Sheets for Hydrograph

Runoff from Slab and Pond

Need to consider this at the same discharge Point as for whole area.

This will be accomplished by using a travel time from the pond discharge to the area discharge

For input to the Program

Area = 3.3 Ac

CN = 99

$t_c = 0.1$

$P = 1''$

SCS Distribution Type III

Compute Travel time using open channel flow equation

$$Q = \frac{1.49}{n} A R^{2/3} \sqrt{S_0}$$

This will only provide an approximation

Assume $Q = 2$ cfs

$$S_0 = \frac{30}{4900} = 0.0061 \text{ ft/ft}$$

30' = vertical drop
4900' = drainage length

By J.D.W Date 2/3/94
Chkd. by RJA Date 2/3/94



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Job No. 16-30912
Sheet No. 4 of 5

Subject _____

Assume size of drainage channel to be



$$A = 5y + 2\left(\frac{1}{2}(y)(2y)\right)$$

$$A = 5y + 2y^2$$

$$P = 5 + 2\sqrt{y^2 + 4y^2}$$

$$P = 5 + 2\sqrt{5y^2}$$

$$P = 5 + 2y\sqrt{5}$$

$$n = 0.03$$

$$2.48 = \frac{1.49}{0.03} (5y + 2y^2) \left[\frac{5y + 2y^2}{5 + 2y\sqrt{5}} \right]^{2/3} \sqrt{0.0061}$$

$$2 = 3.88 (5y + 2y^2) \left[\frac{5y + 2y^2}{5 + 2y\sqrt{5}} \right]^{2/3}$$

Use Program to Solve for y

$$y = 0.25'$$

$$A = 1.4 \text{ ft}^2$$

$$V = Q/A = 2/1.4$$

$$V = 1.4 \text{ fps}$$

Distance from pond discharge to Area outfall = 4,900'

$$t_t = \frac{4900 \text{ ft}}{1.4 \text{ ft/sec}} = 3500 \text{ sec}$$

$$t_t = (3500 \text{ sec}) \left(\frac{1 \text{ min}}{60 \text{ sec}} \right) \left(\frac{1 \text{ hr}}{60 \text{ min}} \right)$$

$$t_t = 0.97 \text{ hr}$$

Travel time = 0.97 hr [This is an approximation]

By JDW Date 2/3/94

Chkd. by EJH Date 2/3/94



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Consulting Engineers, Surveyors & Hydrogeologists

Job No. 16-30912

Sheet No. 5 of 5

Subject _____

Input this into QTRSS Program

$$Area = 3.3 A_c$$

$$CN = 98$$

$$L_c = 0.1 A_c$$

$$P = 1"$$

$$travel\ time = 0.97 h$$

SCS Distribution Type III

Table 2-2c.—Runoff curve numbers for other agricultural lands¹

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. ²	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. ³	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30	48	65	73
Woods—grass combination (orchard or tree farm). ⁴	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. ⁶	Poor	45	66	77	83
	→ Fair	36	60	73	79
	Good	30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

¹Average runoff condition, and $I_a = 0.2S$.²Poor: <50% ground cover or heavily grazed with no mulch.

Fair: 50 to 75% ground cover and not heavily grazed.

Good: >75% ground cover and lightly or only occasionally grazed.

³Poor: <50% ground cover.

Fair: 50 to 75% ground cover.

Good: >75% ground cover.

⁴Actual curve number is less than 30; use CN = 30 for runoff computations.⁵CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.⁶Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

Fair: Woods are grazed but not burned, and some forest litter covers the soil.

Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

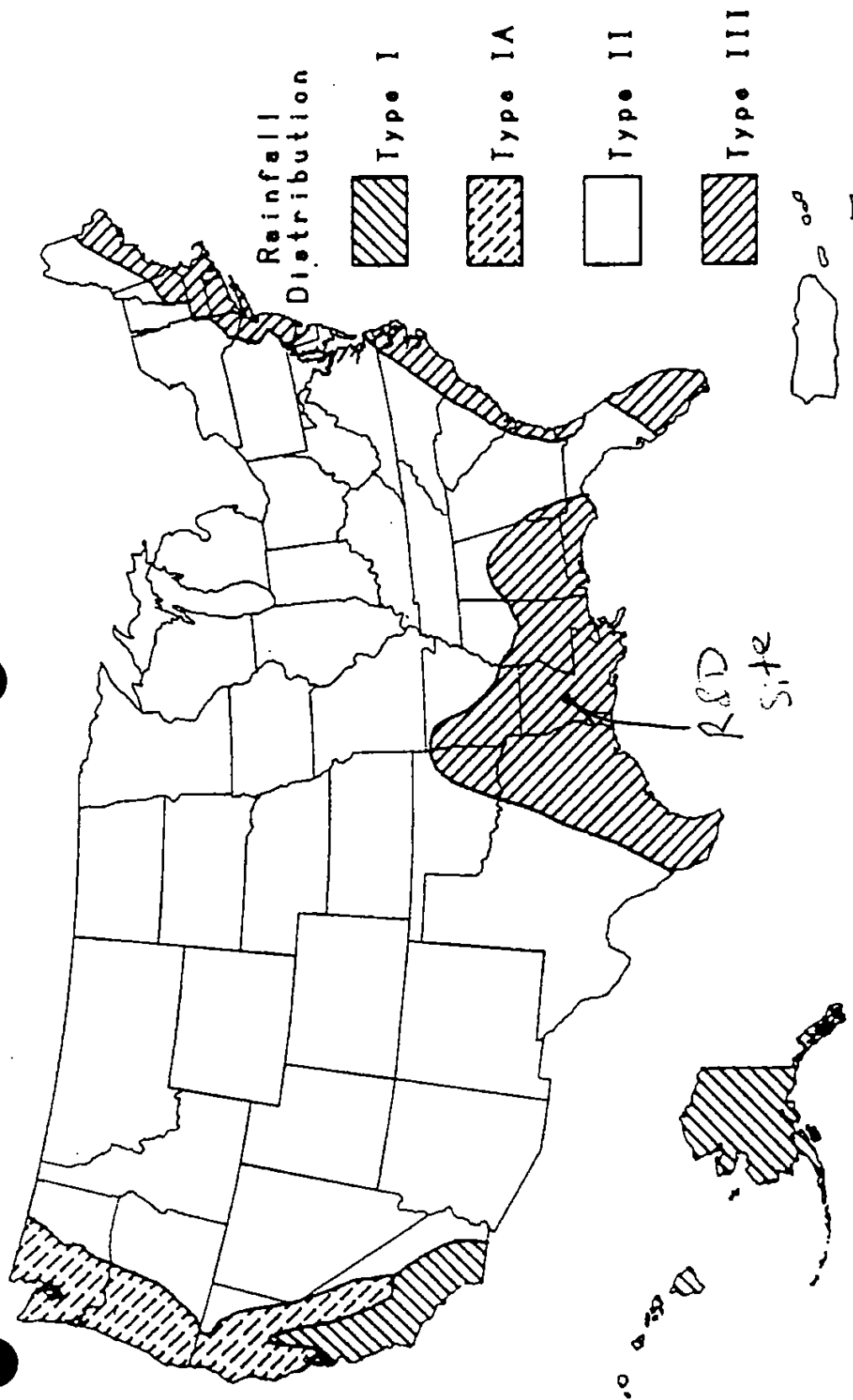
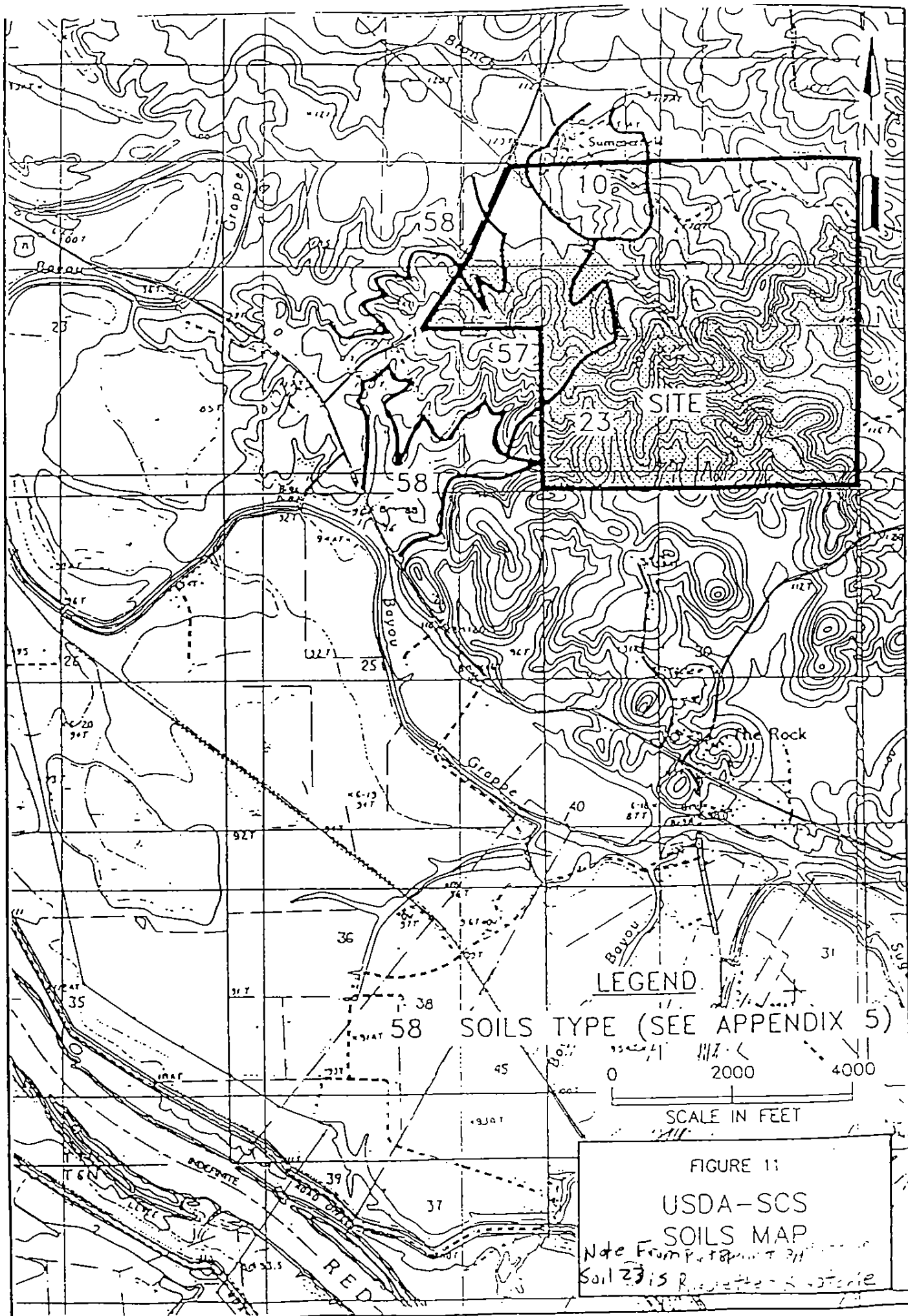
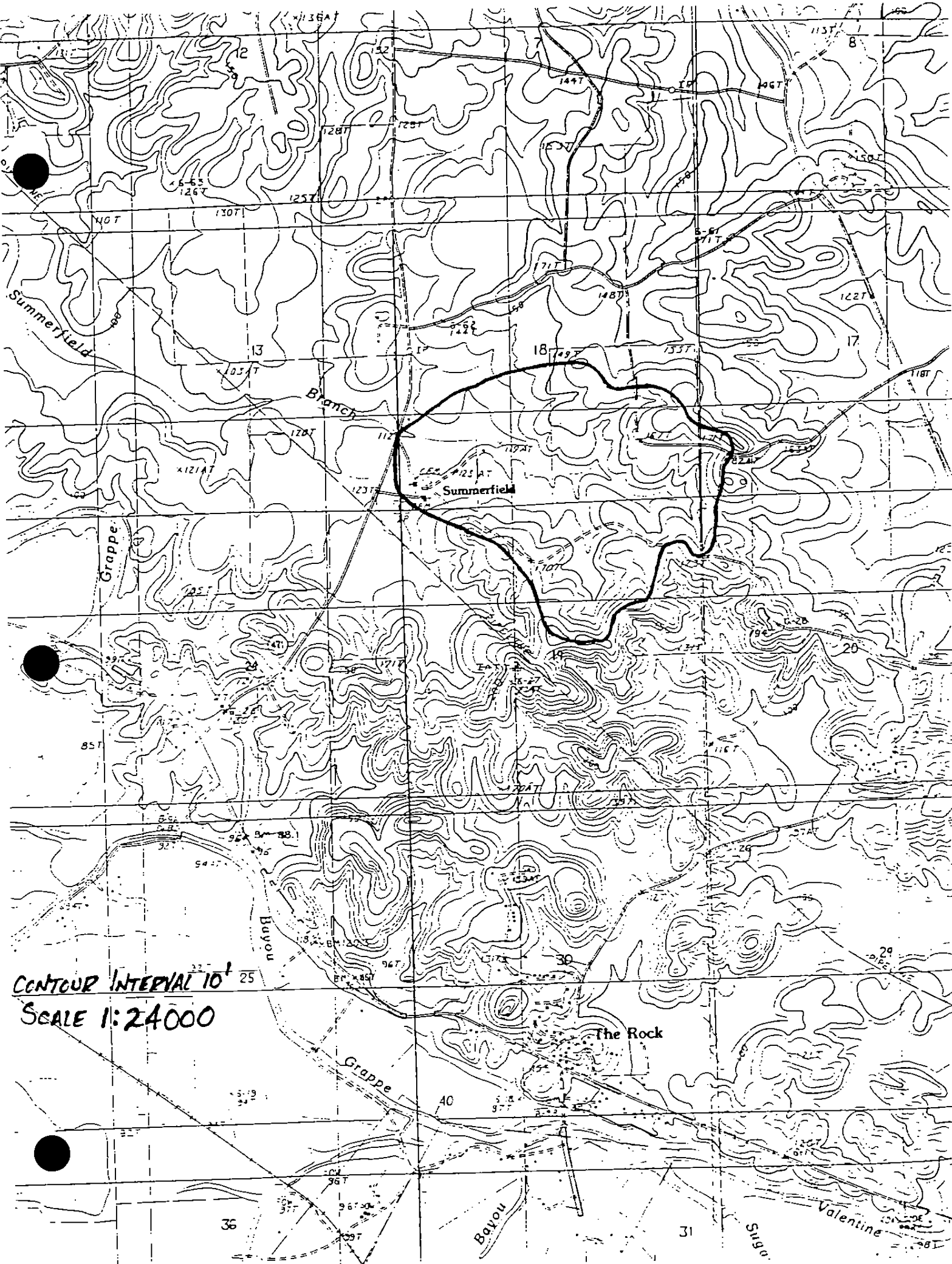


Figure B-2.—Approximate geographic boundaries for SCS rainfall distributions.





CONTOUR INTERVAL 10'
SCALE 1:24000

Exhibit A-1, continued: Hydrologic soil groups for United States soils

BUCHENAU, THICK SOLUM	S	BURCHELL	C	CARDOSO	C	CALODD	C	CANTEEN	B
BUCKAROO	C	BURDETT	C	CARDOSE	B	CALODSA	C	CANTEM	D
BUCKBAY	C	BUREN	C	CARDT	D	CALOUSF	B	CANTINA	C
BUCKCREEK	C	BURGESS	C	CABRILLO	C	CALPAC	B	CANTON	S
BUCKEYE	C	BURGI	B	CABSTON	B	CALPEAK	D	CANTON BEND	C
BUCKHALL	B	BURIBURI	C	CACHE	D	CALPINE	B	CANTRIL	B
BUCKHOUSE	B	BURKE	C	CACIQUE	C	CALPROY	B	CANTUA	B
BUCKING	A	BURKETOWN	C	CACIUSFLAT	C	CALUME	B	CANTUCHE	D
BUCKLAKE	C	BURKEVILLE	D	CADD	D	CALVERTON	C	CANUTIO	B
BUCKLAND	C	BURKHARDT	B	CACEVILLE	D	CALVIN	C	CANWALL	C
BUCKLE	B	BURLEIGH	A/D	CADILLAC	A	CALVISTA	D	CANYON	D
BUCKLEBAR	S	BURLESON	D	CADIZ	B	CALVCOOS	D	CAPAC	C
BUCKLEY	D	BURLEVASH	D	CAOMUS	B	CALZACORTA	D	CAPAY	D
BUCKLICK	C	BURLINGTON	A	CADOMA	D	CAMAGUEY	D	CAPE	D
BUCKLICK, THICK SOLUM	B	CURMAN	D	CAESAR	A	CAMARGO	B	CAPE FEAR	D
BUCKLON	D	BURNAC	D	CAGEY	C	CAMARILLO	C	CAPEHORN	D
BUCKNELL	D	BURNBOROUGH	B	CAGLE	C	CAMARILLO, DRAINED	B	CAPERS	D
BUCKNEY	B	BURNEL	C	CAGUABO	D	CAMAS	A	CAPERION	D
BUCKPEAK	B	BURNETTE	C	CAGWIN	B	CAMAS, STONY	B	CAPHOR	B
BUCKS	B	BURNHAM	D	CAMABA	B	CAMATTA	D	CAPILLO	C
BUCKSHOT	B	BURNSIDE	B	CAMONA	B	CAMBARGE	B	CAPISTRANO	C
BUCKSKIN	C	BURNSVILLE	B	CAIO	B	CAMBERN	C	CAPITAN	D
BUCKTON	B	BURNSWICK	B	CAINHOY	A	CAMBERT	C	CAPJAC	C
BUDE	C	BURNT LAKE	A	CAIRC	D	CAMBETH	C	CAPLEN	D
BUDINOL	D	BURNTRIVER	B	CAJALCO	C	CAMBRIA	B	CAPLES	D
BUDLEVIS	C	BURR	D	CAJETE	B	CAMBRIDGE	C	CAPLES, DRAINED	C
BUELL	S	BURRITA	D	CAJON, OVERWASH	A	CAMOEN	B	CAPONA	C
BUENA VISTA	S	BURROSVILLE	C	CAJON, LOAMY	A	CAMEEK	D	CAPOOSE	C
DUFFARAH	D	BURSLEY	D	SUBSTRATUM	D	CAMELBACK	B	CAPPS	B
DUFFCREEK	B	BURSON	C	CAJON, SILTY	A	CAMEO	B	CAPSHAW	C
DUFFINGTON	S	BURT	D	SUBSTRATUM	D	CAMERON	D	CAPTINA	C
DUFFMEYER	S	BURTON	B	CAJON, ALKALI, OVERWASH	A	CAMILLUS	B	CAPTIVA	B/D
DUFFORK	C	BURWELL	C	CAJON, OVERWASH	B	CAMINO	C	CAPULIN	B
DUFFON	C	BUSBY	B	CAJON	B	CAMPANA	B	CARACOLES	D
DUMRIG	C	BUSE	B	SALINE-ALKALI	B	CAMPBELL, MUCK	C	CARADAN	C
DUMICK	C	BUSHER	B	CAJON, COOL, OVERWASH	A	SUBSTRATUM	B	CARALAMPI	B
DUMIST	B	BUSHMAN	B	CAJON, GRAVELLY	A	CAMPBELL, DRAINED	B	CARBENGLE	B
DUMK	B	BUSHNELL	C	CAJON, COOL	A	CAMPBELLTON	C	CARRO	C
DUMK	B	BUSHVALLEY	D	CAJON, COOL	A	CAMPBELLTON	C	CARBOL	D
DUMK	B	BUSKA	B	CAJON, WARM	A	CAMPDIA	B	CARPONA	D
DUMK, WEI	C	BUSSEY	C	CALABAR	D	CAMPO	C	CARBONDALE	A/D
DUMKREEK	S	BUSTED	B	CALAPASAS	B	CAMPONE	C	CARCITY	D
DUMLAKE	D	BUSTI	C	CALAMINE	D	CAMPSPASS	B	CARDENAS	C
DUMKLEY	C	BUSWILD	B	CALAPITY	D	CAMPUS	B	CARDIFF	B
DUMRUM	S	BUTANO	C	CALAPUS	A	CAMPDEN	C	CARDIGAN	B
DUMRUM, HARDPAN	C	BUTCHE	C	CALAYERAS	B	CANA	C	CARDINGTON	C
SUBSTRATUM		BUTLER	D	CALAYAN	B	CANAAN	C	CARDON	C
DUM TRAIL	B	BUTLERTOWN	C	CALCO	B/D	CANADIAN	B	CAREFREE	D
DUM LARDS	B	BUTTERFIELD	C	CALCOUSTA	B/D	CANADICE	D	CAREY	B
DUMCREEK	D	BUTTERMILK	B	CALCROSS	B	CANALOU	B	CAREY LAKE	B
DUMFLAT	B	BUTTERS	B	CALO	C	CANANDAIGUA	D	CARGENT	B
DUMFOR	C	BUTTON	D	CALDER	D	CANASERAGA	C	CARGILL	C
DUMTION	D	BUTTONHOOK	B	CALDERWOOD	D	CANAYERAL	C	CARIBEL	B
DUMMEL	C	BUTTONWILLOW	C	CALDWELL	C	CANBURN	D	CARIBOU	S
DUMLOCK	D	EUXIN	D	CALDWELL, DRAINED	B	CANDELARIA	B	CARIOCA	B
DUMLEY	B	EUXTON, SOMEWHAT	D	CAL	B	CANDELERO	C	CARIS	C
DUMLUMP	S	POORLY DRAINED	C	CALFAST	C	CANDERLY	B	CARJO	C
DUMLYARO	B	EUXTON, STONY	C	CALF	B	CANDLER	A	CARLIN	D
DUM INKLE	D	EUXTON, MODERATELY	C	CALCONIA	B	CANOLESTICK	C	CARLINTON	C
DUMLY	B	VELL DRAINED	C	CALCONAR	C	CANDOR	A	CARLISLE	A/D
DUMLOW	A	BUZZIN	A	CALCPA	C	CANE	C	CARLITO	D
DUMCOMBE	A	BYARS	D	CALHI	A	CANEADEA	D	CARLOS	A/D
DUMDO	S	BYBEE	C	CALHOUN	D	CANEEK	B	CARLOTTA	B
DUMDOOF	D	BYINGTON	C	CALICO	C	CANEO	D	CARLOW	D
DUMDY	C	BYLER	C	CALICOTT	A	CANEST	D	CARLSBAD	C
DUMDYMAN	C	BYLU	B	CALICON	C	CANEYVILLE	C	CARLSBOURG	A
DUMJUG	C	BYNUM	C	CALINUS	B	CANEZ	B	CARLSON	B
DUMKER	B	BYRAM	C	CALITA	B	CANFIELD	C	CARLSTON	C
DUMKERHILL	D	BYRNIE	D	CALIZA	B	CANISTEC	B/D	CARLTON	C
DUMKATER	C	CABALLO	B	CALKINS	C	CANISTEC, STONY	D	CARMACK	B
DUMKEY	C	CASARTON	C	CALLABO	C	CANTIE	B	CARMEL	C
DUMNELL	B	CASSA	D	CALLAMAH	D	CANLON	D	CARMI	B
DUMSELMEIER	B	CABBART	C	CALLAN	C	CANNELL	B	CARMICHAEL	C
DUMTINGVILLE	C	CABBART, STONY	D	CALLEGUAS	D	CANNING	B	CARMODY	C
DUMYAN	S	CAPBART, WARM	D	CALLINGS	C	CANNON	B	CARNASAW	C
DUMBANK	A	CABERN	D	CALLISBURG	C	CANNONVILLE	D	CARNEGIE	C
DUMBACH	S	CABIN	B	CALLICAY	C	CANCE	B	CARNEIRO	C
DUMCHAM	A	CABINET	C	CALMAR	B	CANCYA	B/D	CARNEY	D
DUMCHAWO	S	CABLE	B/D	CALNEVA	C	CANTALA	B	CAROLINE	C

ES: TWO HYDROLOGIC SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION. MODIFIERS SHOWN, E.G., BEDROCK SUBSTRATUM, REFER TO A SPECIFIC SOIL SERIES PHASE FOUND IN SOIL MAP LEGEND.

Exhibit A-1, continued: Hydrologic soil groups for United States soils

GLOHM	C	GOOSEFLATS	D	GRANGEVILLE.	E	GRELLTON	B	GUAYABOTA	D
GLORIA	D	GOOSMUS	B	DRAINED		GRENADA	C	GUAYAMA	D
GLOUCESTER	A	GORDO	B	GRANGEVILLE.	E	GRENADIER	B	GUPE	C
GLOVER	C/D	GORE	D	OCCASIONALLY		GRENVILLE	F	GUBEN	E
GLYNDOH	B	GOREEN	D	FLOODED		GRESHAM	C	GUCKEEN	C
GLYNN	C	GORGAS	D	GRANILE	F	GRETOIVIO	E	GUGEL	C
GLYWOOD	C	GORGONIO	A	GRANMOUNT	C	GREVINGX	C	GUDGREY	9
GLYPHS	B	GORHAM	B/D	GRAND	D	GREYBACK	B	GUELPH	B
GOBAR	B	GORIN	C	GRANSHAW	F	GREYBO	E	GUEMES	B
GOBERNADOR	D	GORING	C	GRANT	B	GREYBULL	C	GUENOC	C
GOSINE	B	GORMAN	C	GRANTFORK	D	GREYEAGLE	D	GUENTHER	E
GOBLE	C	GORSKEL	D	GRANTHAM	D	GREYS	B	GUERNSEY	C
GOBLIN	D	GORST	D	GRANTSBURG	C	GRIBBLE	D	GUERO	C
GOCHEA	B	GORUS	B	GRANTSDALE	B	GRIDELL	D	GUERRERO	A
GODOARO	B	GORZELL	B	GRANYVILLE	B	GRIDGE	D	GUEST	D
GODOE	D	GOSA	B	GRANYON	B	GRIDLEY	C	GUFFEY	C
GODDING	C	GOSHEN	B	GRANZAM	B	GRIETA	B	GUFFIN	D
GODECKE	D	GOSHUTE	D	GRADYVINE	B	GRIEVES	F	GUGUAX	G
GODFREY	D	GOSINTA	C	GRAPIT	E	GRIFFITH	D	GUILDEP	C
GODWIN	D	GOSLIN	B	GRASHUL	C	GRIFFY	E	GUISEY	B
GOEMMER	C	GOSNEY	D	GRASPERE	E	GRIFFTON	C	GULER	E
GOESLING	B	GOSPER	B	GRASSMA	E	GRISSBY	B	GULF	B/D
GOESSEL	D	GOSPORT	C	GRASSVAL	D	GRIGSTON	F	GULKANA	B
GOFFPEAK	B	GOSSE	B	GRASSVALLEY	D	GRIMM	A	GULNARE	D
GOGBIC	B	GOSUMI	D	GRASSY BUTTE	A	GRIMM, STONY	B	GUMBLE	D
GOL	D	GOTEBD	B	GRASSY CONE	A	GRIMSLEY	B	GUMBOOT	D
GOL	C	GOTHAM	A	GRAT	D	GRIMSTAD	E	GUMBOOT, DRAINED	C
GOL. NONSTONY	C	GOTHARD	C	GRATTAN	A	GRIMSTONE	B	GUNBARREL, SALINE	D
GOL. GRAVELLY	C	GOTHENBURG	D	GRAUFELS	C	GRINA	D	GUNBARREL, DRAINED	A
GOLCONDA	C	GOTHIC	C	GRAYDEN	E/C	GRINDALL	D	GUND	C
GOLD CREEK	D	GOTHO	C	GRAYELTON	B/C	GRINDBROOK	C	GUNDY	C
GOLDBERG	D	GOTHO, MODERATELY	B	GRAVIER	B	GRINDSTONE	C	GUNLCK	C
GOLDENALE	B	WET		GRAYBERT	B	GRINDSTONE	C	GUNN	B
GOLDFINCH	D	GOTHO, COOL	B	GRAYCALM	A	GRINPOD	C	GUNNEL	D
GOLDHEAD	B/D	GOULDING	D	GRAYFORD	B	GRISDALE	B	GUNSIGHT	9
GOLDHILL	D	GOULDSBORO	D	GRAYLAND	D	GRISWOLD	B	GUNSONE	D
GOLDHILL, LOAMY	C	GOURDIN	C	GRAYLAND, DRAINED	C	GRITNEY	C	GUNSTOCK	C
SUBSTRATUM		GOURLEY	C	GRAYLING	A	GRIVER	C	GUNTER	B
GOLDLAKE	B	GOVE	B	GRAYLOCK	A	GRIVER, WET	D	GUP	C
GOLDMAN	C	GOVEN	B	GRAYLOCK, STONY	B	GRIVER, DRAINED	B	GURDANE	C
GOLDMIRE	C	GOWKER	C	GRAYPOINT	B	GRIZZLY	B	GURDON	C
GOLDRIDGE	B	GOWTON	B	GRAYPOINT, WET	C	GROBUTTE	B	GURLEY	C
GOLORUM	A	GOZEM	D	GRAYROCK	C	GROGAN	B	GURNEY	B
GOLDSBORO	B	GRABE	B	GRAYROCK	B	GROOM	C	GUSTIN	D
GOLDSTON	C	GRABLE	B	GRAYSILL	C	GROSECLOSE	C	GUSTSPRING	B
GOLDSTREAM	D	GRACEMONT	C	GRAZER	C	GROSS	C	GUTHRIE	D
GOLDSTREAM, THAWED	B	GRACEMORE	C	GRAT BEND	E	GROSSWELL	C	GUY	B
GOLDUST	C	GRACEVILLE	B	GREDGE	D	GROTON	A	GUYAN	C
GOLDVALE	B	GRADCO	C	GREEN BLUFF	E	GROTTE	B	GUYANDOTTE	D
GOLDVALE, NONSTONY	C	GRADON	C	GREEN CANYON	B	GROTTO	A	GUYTON	D
GOLDVEIN	C	GRADY	D	GREEN RIVER	C	GROUSECREEK	B	GWENA	D
GOLDYKE	D	GRAFEN	B	GREEN RIVER.	F	GROUSEVILLE	C	GWIN	D
GOLETA	B	GRAFF	D	STRONGLY SALINE		GROVE	A	GWIN, GRAVELLY	C
GOLIAD	C	GRAHAM	D	GREEN RIVER.	F	GROVECITY	B	GWINLY	D
GOLLAMER	D	GRAIL	C	FLOODED		GREVENA	E	GWINNETT	B
GOLSUM	C	GRANOLA	D	GREENBRAE	C	GROVER	B	GYMER	C
GOLTRY	A	GRALEY	D	GREENBRIAR	B	GROYETON	B	GYNELLE	A
GOLVA	B	GRALIC	B	GREENCREEK	B	GROWDEN	C	GYPNEVEE	B
GOMERY	B	GRAN	D	GREENDALE	E	GROWLER	B	GYSTUM	C
GOMEZ	B	GRANATH	B	GREENE	B	GROWTON	D	HAAR	D
GOMVICK	B	GRANBY	A/D	GREENFIELD	B	GRUBBS	B	HAARVAR	D
GONZAGA	C	GRANDE RONDE	D	GREENFIELD.	C	GRUBSTAKE	C	HACCKE	C
GOOCH	D	GRANFIELD	B	HARDPAN		GRUENE	D	HACK	B
GOODING	D	GRANDMORE	B	SUBSTRATUM		GRULLA	D	HACKBERRY	B
GOODINGTON	D	GRANDPON	B	GREENHALGH	B	GRUMMIT	D	HACKERS	B
GOODLAND	B	GRANDVIEW	C	GREENHORN	D	GRUNOY	C	HACKROY	D
GOODLOW	B	GRANDVIEW, DRAINED	B	GREENLEAF	E	GRUYER	C	HACKWOOD	B
GOODMAN	B	GRANER	B	GREENLEE	B	GRYGLA	B/D	HADAR	E
GOODNIGHT	A	GRANGE	C	GREENMAN	C	GSCHWEND	B	HADENCREEK	C
GOODPASTER	D	GRANGEMONT	C	GREENOUGH	B	GUADALUPE	B	HADLES	B
GOODPICH	B	GRANGEVILLE.	B	GREENSON	C	GUAJE	D	HADLEY	B
GOODSPRINGS	D	DRAINED, SLOPING		GREENTON	C	GUAM	D	HADSELYVILLE	D
GOODWILL	B	GRANGEVILLE.	C	GREENVILLE	B	GUAMANI	B	HAFLINGER	A
GOODWIN	B	SALINE-ALKALI.		GREENVINE	D	GUANABANO	C	HAGEN	B
GOODWAY	C	WET		GREENWATER	A	GUANAJISO	D	HAGENBARTH	B
GOOSE CREEK	B	GRANGEVILLE.	B	GREENWAY	B	GUANICA	D	HAGER	D
GOOSE CREEK, WET	C	SALINE-ALKALI		GREENWOOD	A/D	GUARD	C	HAGERMAN	C
GOOSE LAKE	D	GRANGEVILLE.	B	GREENWY	B	GUAPOLAKE	A	HAGERSTOWN	C
GOOSEBURY	B	MODERATELY WET		GRELL	D	GUAYABO	A	HAGGA	D

NOTES: TWO HYDROLOGIC SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION. MODIFIERS SHOWN. E.G., BEDROCK SUBSTRATUM, REFER TO A SPECIFIC SOIL SERIES PHASE FOUND IN SOIL MAP LEGEND.

Exhibit A-1, continued: Hydrologic soil groups for United States soils

RAYPOL	C	REDSTONE	A	RENIX	B	RICOT	C	RETIDIAN	D
RAZ	D	REDSUM	D	RENSHAW	B	RICREST	B	RETNER	C
RAZITO	A	REDTHAYNE	B	RENSLOW	B	RIO	C	RITO	B
RAZOR	C	REDTOM	B	RENSSELAER	B/D	RIOLES	B	RITTER	B
RAZORBA	B	REDVALE	C	RENSSELAER.	C	RIDENBAUGH	D	RITTMAN	C
RAZORT	B	REDVIEW	B	NONSTRATIFIED	B	RIOGE	B	RITZ	D
RAZSUM	D	REDVIEW, VET	C	SUBSTRATUM	C	RIDGE	C	RITZ, DRAINED	C
READING	B	REOVINE	C	RENTILL	E	RIDGECREST	C	RITZCAL	B
READINGTON	C	REDWASH	D	RENTON	D	RIDGE DALE	B	RITZVILLE	B
READLYN	B	REE	B	RENTON, DRAINED	C	RIDGELAND	B/D	RIVALIER	B
REAGAN	B	REEBOX	D	RENTSAC	D	RIDGELAWN	B	RIVERDALE	A
REAKOR	B	REED	D	RENTZEL	C	RIDGELAWN, VET	D	RIVERHEAD	B
REAL	D	REED, DRAINED	C	REPARADA	D	RIDGELITE	D	RIVERHOLD	B
REALLIS	B	REED, PROTECTED	C	REPP	B	RIDGEPORT	B	RIVERSIDE	A
REAP	D	REEDER	B	REPPART	B	RIDGEVIEW	D	RIVERTON	B
REARDAM	C	REEDER, COOL	C	REPUBLIC	B	RIDGEVILLE	B	RIVERVIEW	B
REAVILLE	C	REEDSBURG	C	RESCUE	E	RIDGEWOOD	C	RIVIERA	C/D
REAVIS	B	REEDSPORT	C	RESNEP	B	RIDIT	C	RIVIERA,	D
REBA	C	REEDY	D	RESORT	D	RIDLEY	C	DEPRESSIONAL	B
REBEL	B	REFRIDGE	D	RESOTA	A	RIDOT7	C	RIVIERA, LIMESTONE	B/D
RECAPTURE	S	REELFOOT	C	RESTING	C	RIDDEL	C	SUBSTRATUM	D
RECK	D	REEPO	C	RESTON	D	RIDETOWN	C	RIVIERA, LIMESTONE	D
RECLUSE	B	REESE	C	RET	D	RIEPE	C	SUBSTRATUM,	B
RED BAY	B	REESER	C	RETRIEVER	D	RIESEL	C	DEPRESSIONAL	B
RED BLUFF	C	REESVILLE	C	RETROP	C	RIBTBROCK	C	RIVRA	D
RED BLUFF,	B	REEVES	B	RETRYOE	B	RIFLE	A/D	RIXIE	C
GRAVELLY	B	REFLECTION	B	REVA	C	RIGA	D	RIXON	C
RED BUTTE	B	REFUGE	C	REVEL	C	RIGDON	C	RIZ	D
RED HILL	B	REGAL	B/D	REVENTON	B/D	RIGGINS	D	RIZNO	D
RED HOOK	C	REGAN	B/D	REVERE	B/D	RIGGS	D	RIZOZO	D
RED ROCK	B	REGENT	C	REVIT	C	RIGLEY	B	ROANE	C
RED SPUR	B	REGGAD	A	REWARD	B	<u>RIGLITTE</u>	C	ROANHIDE	C
REDARROW	D	REGGEAR	D	REXBURG	B	RILEY	B	ROANOKE	D
REDBANK	B	REGGEAR, COOL	C	REXFORD	C	RILLA	B	ROARING	B
REDBELL	B	REGNAPS	C	REXMONI	D	RILLINO	B	ROB POY	C
REDBIRD	B	REGNIER	D	REXOR	A	RILLITO	B	ROBANA	B
REDBOW	C	REHBURG	C	REYAB	B	RIMER	C	ROBBS	D
REDSY	B	REHFIELD	B	REYES	D	RIMINT	A	ROBGO	C
REDCAMERON	D	REHFIELD	C	REYNOSA	E	RINROCK	D	ROBFR	C
REDCAN	D	REHM	C	REYVAT	D	RINTON	C	ROBERTSDALE	C
REDCAP	B	REICISS	B	REZAYE	C	RIN	B	ROBERTSVILLE	B
REDCHEIF	C	REICHEL	B	REHAME	B	RINCON	C	ROBIN	B
REDCLIFF	C	REIFF	B	REHCA	B	RINDA	D	ROBINETTE	B
REDCLOUD	B	REILLY	A	RHINEBECK	D	RINDGE	D	ROBINSONVILLE	B
REDCO	D	REINA	D	RHODES	D	RINDGE, DRAINED	C	ROBOZO	C
REDCREEK	D	REINACH	B	RHODME	C	RINEARSON	E	ROBPOOST	B
REDDALE	D	REINER	B	RHODMETT	C	RINEY	B	ROBSON	D
REDDICK	B/D	REKOP	D	RHODMETT, STONY	C	RING	C	ROBY	C
REDDING	D	RELAN	B	PHONE	B	RINGLE	B	ROCA	D
REDEYE	B	RELAY	B	RIB	B	RINGLING	B/D	ROCHE	D
REDFEATHER	D	RELJANCE	C	RIBERA	C	RINGO	C	ROCHELLE	D
REDFIELD	B	RELIZ	D	RIBHILL	B	RINGWOOD	B	ROCHER	B
REDFIELD, VET	C	RELLEY	B	RICCO	D	RINKER	C	ROCHESTER	A
REDFLAME	B	RELSOB	B	RICEBORO	B/D	RIO	C	ROCTO	C
REDHOUSE	B	RELUCTAN	C	RICECROSS	B	RIO ARRIBA	D	ROCK CREEK	D
REDIG	B	REMBERT	D	RICERT	B	RIO DIABLO	C	ROCK RIVER	B
REDINGTON	D	REMEDIOS	C	RICETON	B	RIO GRANDE	B	ROCKABIN	C
REDLAKE	D	REMLAP	C	RICEVILLE	C	RIO LAJAS	A	ROCKAWAY	C
REDLANOS	C	REMLIK	A	RICH	C	RIO PIEDRAS	B	ROCKBRIDGE	B
REDLEVEL	C	REMMIT	B	RICH, VET	D	RIOBLANCHO	C	ROCKCASTLE	D
REDLOGE	D	RENNY	D	RICHARDSON	B	RIOCONCHO	C	ROCKDALE	A
REDMANSON	B	RENOTE	B	RICHENS	C	RIGLINDA	C	ROCKDALE	C
REDMONO	C	REMSEN	D	RICHEV	C	RION	B	ROCKERS	B
REDMUNT	B	REMUNDA	C	RICHFIELD	B	RIPEC	D	ROCKFIELD	B
REDNIK	B	REMUS	B	RICHFCRG	B	RIPLEY	A	ROCKFORD	B
REDNIX, NONSTONY	C	PENBAC	D	RICHLAND	D	RIPLEY,	C	ROCKHOUSE	A
REDNUM	C	PENCALSON	C	RICHMOND	C	SALINE-ALKALI,	C	ROCKINCHAIR	C
REDOLA	B	RENCOT	D	RICHSUM	D	WET	B	ROCKLIN	D
REDONA	B	RENFROW	D	RICHTER	B	RIPON	B	ROCKLY	D
REDONDO	B	RENICK	D	RICHVALE	B	RIPPLE	B	ROCKO	B
REDPOP	C	RENISH	C	RICHVIEW	C	RIPROWAN	C	ROCKTON	B
REDPORT	B	RENNER	B	RICHVILLE	C	RIRIE	B	ROCKWELL	B/D
REDRIDGE	B	RENNIE	D	RICHWOOD	B	RISBECK	B	ROCKWOOD	C
REDRIVER	C	RENNIE, DRAINED	C	RICKER	A	RISLEY	D	ROCKY FORD	B
REDROB	C	RENNIE, PROTECTED	C	RICKETTS	C	RISLEY, STONY	C	ROCKYBAR	B
REDSPEAR	D	RENO	D	RICKMAN	D	RISUE	D	RODAD	C
REDSRINGS	B	RENOHILL	C	RICKMORE	C	RISWOLD	B	RODELL	C
REDSRINGS, GRADED	D	RENOL	C	RICKREALL	D	RITA	D	RODED	D
REOSTOE	B	PENDVA	B	RICKS	A	RITCHEY	D	RODESSA	D

NOTES: TWO HYDROLOGIC SOIL GROUPS SUCH AS B/C INDICATES THE DRAINED/UNDRAINED SITUATION. MODIFIERS SHOWN, E.G., BEDROCK SUBSTRATUM, REFER TO A SPECIFIC SOIL SERIES PHASE FOUND IN SOIL MAP LEGEND.

Briefly, the method involves superimposing a transparent grid over a topographic map of the drainage area in question. Each grid line is measured between its intersections with the drainage divide; the number of intersections of each grid line with a contour line is also needed. A determination of the land slope can then be made using

$$S = \frac{n \sec \theta}{l} h \quad (10.4)$$

where n = the total number of contour intersections by the horizontal and vertical grid lines

l = the total length of grid line segments (horizontal and vertical)

h = the contour interval

θ = the angle measured between a normal to the contours and the grid line

Because θ is very difficult to measure, it is often neglected and separate values of average slope in the horizontal and vertical are computed and then averaged to obtain an estimate of the mean land slope. This procedure is illustrated in Fig. 10.5.

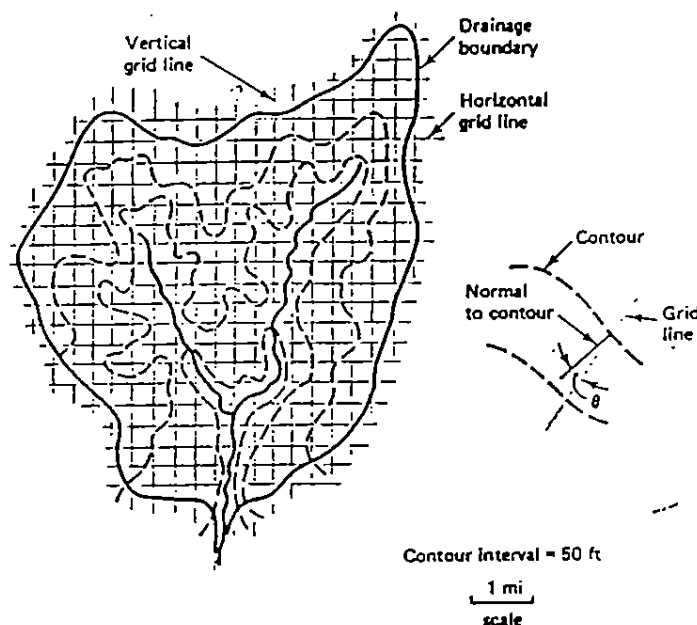


Figure 10.5 Determination of mean land slope: number of vertical intersections = 72; number of horizontal intersections = 120; total length of vertical grid segments = 103,900 ft; total length of horizontal grid segments = 101,200 ft.

$$S_v = \frac{72 \times 50}{103,900} = 0.035 \text{ ft/ft} \quad S_H = \frac{120 \times 50}{101,200} = 0.059 \text{ ft/ft}$$

$$\text{Mean slope} = \frac{S_v + S_H}{2} = \frac{0.035 + 0.059}{2} = 0.047 \text{ ft/ft}$$

SECTION IV
SOIL SURFACE

January 1994

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- 4-B LYSIMETER BORING LOGS**

SECTION IV - SOIL SURFACE

4.1 SITE CHARACTERIZATION

Soils found on the site are classified in the Rigolette-Kisatchie Association, according to the Wetland Determination report prepared by Espey, Huston & Associates, Inc. (Appendix 3-A). The Rigolette-Kisatchie soils are not listed as hydric in the Soil Conservation Service Soil Survey of Grant Parish, 1981.

Soil conditions across the site are nonuniform, and generally consist of several inches of gray sandy loam topsoil overlying reddish brown, red, and/or gray sands, clayey sands, sandy clays and/or clays. Sand pockets and iron oxide staining are scattered throughout the soils. See Geotechnical Investigation included in Section II, Appendix A. Soils at the site appear to be of alluvial deposition. As depth increases, the soils become more preconsolidated, probably due to overburden pressure and desiccation. The deeper sands show cementation (sandstone).

According to the geotechnical investigation, the upper sandy soils possess only moderate shrink/swell potential that may occur as a result of seasonal moisture variations. The deeper clay soils have very high plasticity indices; however, some swell potential should never be realized since the site is in an area of fairly high year-round rainfall, which tends to maintain an equilibrium soil moisture.

Six (6) soil samples from varying depths were submitted for geotechnical analyses to determine permeability of soils. See Geotechnical Analyses included in Section II, Appendix C. The soil samples submitted for analysis were varying clays from depths of 16'-18', 4'-5', 9'-10', 39', 104'-108', and 3'-4' below ground surface. Analytical results of these clay soils indicated permeabilities ranging from 8.6×10^{-7} centimeters/second (cm/sec) to 4.0×10^{-5} cm/sec.

A seismic geophysical study performed at the site revealed the site is dominated by sands, sandstones, and clays. See Seismic Geophysical Survey included in Section II, Appendix F. The sand units range in hardness from very loose soils to very hard, but still rippable, sandstones. Deeper units, greater than 60 feet, are probably continuous (or at least more correlatable) across the site; whereas the shallower units, less than 60 feet, are probably discontinuous.

4.2 SCREENING ASSESSMENT

The soil screening assessment for the Laidlaw Environmental Services (Thermal Treatment), Inc. (LESI) facility consists of the following tasks:

- Modeling deposition of particulates and analyzing human health and ecological risk from soil ingestion.
- Reviewing the impact of fugitive dust emissions from onsite vehicular traffic.
- Continuing assessment of the soil surface and vadose zone through monitoring, sampling and analysis.

Surface runoff of contaminants resulting from particle deposition is addressed in Section III.

Section V - Air, analyzes the human health and ecological risk associated with ingestion of soil that may receive particulate fallout from the thermal treatment units. The metals Al, Ba, Be, Cr, Cu, Ni, Pb, Sb, Se, Zn, and Hg were included in this assessment.

Section 4.2.1 addresses fugitive dust emissions from onsite traffic using methodology adapted from the guidance document "Compilation of Air Pollutant Emission Factors (EPA AP-42)".

Fugitive dusts are not considered a threat in terms of particulate deposition and are considered here only to assess the general particulate contribution of onsite traffic to ambient air. Ongoing soil assessment activities discussed in Section 4.2.2 will be used to monitor soil adjacent to the thermal treatment units and at downwind locations.

4.2.1 Fugitive Dusts

Figure 1-1 shows the facility road system as well as the general layout of the storage and treatment units. The entrance and process area roads were constructed of compacted subgrade covered by a compacted washed river gravel. Traffic enters the facility from a paved roadway and is anticipated to be at low volume (≤ 6 VPD AVG.) over the life of the facility.

Section 11.2.1 from the AP-42 guidance document contains procedures for assessing the potential dust loading from travel on unpaved roads. AP-42 addresses particle size in relation to dispersion of dusts as follows:

"... for a typical mean wind speed of 10 miles/hr, particles larger than about 100 micrometers are likely to settle out within 6 to 9 meters from the edge of the road. Particles that are 30 to 100 micrometers in diameter are likely to undergo impeded settling. These particles, depending upon the extent of atmospheric turbulence, are likely to settle within a few hundred feet from the road."

According to AP-42, the dust emissions from unpaved roads have been found to vary in direct proportion to the fraction of silt in the road surface material. The following empirical equation provides an estimate of particulate emissions from an unpaved road, per vehicle mile traveled. An estimate of the silt content of the gravel gives this equation a reliability rating of B.

$$E = k (5.9) \left(\frac{s}{12} \right) \left(\frac{S}{30} \right) \left(\frac{W}{3} \right)^{0.7} \left(\frac{w}{4} \right)^{0.5} \left(\frac{365-p}{365} \right)$$

The equation variables, definitions and input parameters () are listed below.

E = emission factor (lb/vehicle mile traveled)

k = particle size multiplier (0.8)

s = silt content of road surface material (5%)

S = mean vehicle speed (15 mph)

W = mean vehicle weight (10 ton)

w = mean number wheels (14)

p = number of days with at least 0.01 in. precipitation (80)

Table 11.2.1-1 of Section 11.2.1 (AP-42) provides typical silt content values of surface material for rural unpaved roads. The mean silt content by weight for gravel roads is 5%. The particle size multiplier (k) is 0.8 based upon a particle size range ≤ 30 μ m. Based upon climatological data contained in Appendix 3-B, the Alexandria vicinity had an average 68 days per year with precipitation of at least 0.1 inches. The input parameter (p) was estimated at 80 days per year as the number of days receiving at least 0.01 inches of precipitation. Input parameters to the equation are as follows:

$$E = 0.8 (5.9) \left(\frac{5}{12} \right) \left(\frac{15}{30} \right) \left(\frac{10}{3} \right)^{0.7} \left(\frac{14}{4} \right)^{0.5} \left(\frac{365-80}{365} \right)$$

These input parameters result in an emission rate of 3.35 lb/VMT. At an estimated 6 vehicles per day and an average 0.4 mile round trip per vehicle, the average daily particulate emission rate for particles ≤ 30 um in diameter is:

$$3.35 \text{ lb/VMT} \times 6 \text{ vehicles/day} \times 0.4 \text{ miles} = 8.1 \text{ lb/day}$$

Based upon the fact that washed river gravel was used for the road base, the assumption of 5 percent by weight silt content is very conservative. Thus, the calculated value is likely to exceed the true emissions based upon actual silt content.

Natural vegetation will be maintained in a minimum 1000 foot buffer zone around the operations area to isolate this area from surrounding property. Pine and hardwood forests surrounding facility roads will help to trap particulate matter and will serve as a wind break to minimize the potential for particulates to become airborne. No other controls are necessary based upon the low quantity of particulates generated and the natural isolation of the area.

4.2.2 Soil Assessment

4.2.2.1 Soil Monitoring Plan

In order to address the concern of deposition of particulates from thermal treatment of wastes, LESI has included design safeguards. The concrete pad surrounding the thermal treatment units is the primary or worst case waste management area in terms of potential for contaminants to escape the unit. Subsequent to preparation, wastes will be transported across the pad to a treatment unit. Each treatment unit contains an additional concrete containment area; therefore, spillage and fallout in the immediate vicinity of the treatment unit will be contained. Additional steel and concrete containment area is provided for the storage magazines, preparation building, truck staging and parking areas.

In addition to design safeguards, LESI will implement a soil monitoring program to monitor both surface and subsurface soil in the vicinity of the thermal treatment units. The soil monitoring program calls for surface soil samples to be collected from locations at specified distances from the facility perimeter fence. Soil sampling locations were chosen as worst case impact areas based upon prevailing wind data.

Prior to initiating thermal treatment, background samples will be collected. After one year of operation, a second set of samples will be collected to determine if a statistically significant increase in monitored parameters has occurred. Samples will be analyzed for total metals, volatile organic compounds and USATHAMA Extractable Explosives. The Soil Monitoring Plan is included as Appendix 4-A.

4.2.2.2 Vadose Zone Monitoring

Six (6) monitoring locations, L1 through L6, have been established outside the perimeter of the thermal treatment area in order to monitor the vadose zone (see Figure 1-1). Appendix 4-B contains the lysimeter construction details and the soil boring logs for each location.

Lysimeters were installed utilizing a truck-mounted hydraulic drill rig with hollow-stem augers. Each lysimeter was constructed to a depth of approximately 10 feet below ground surface (BGS) using flush-joint, 2-inch diameter schedule 40 blank PVC riser pipe and machine slotted schedule 40 PVC well screen with 0.010-inch slots. Six feet of screen was placed in each lysimeter, from 4 feet BGS to 10 feet BGS. The annulus between the screen and borehole wall was filled with a uniformly graded 20/40 sand filter pack, extending one foot above the top of the screen. A one foot bentonite pellet seal was placed above the sand filter pack and hydrated 12 hours to seal the annulus and prevent surface water from entering the lysimeter through the annular space. The remaining annular space was grouted

to the surface with a cement-bentonite grout. Each lysimeter was equipped with a locking cap and a 5' x 4" lockable steel, above ground protector set in a 2' x 2' concrete pad. Groundwater was not encountered during lysimeter installation.

Each lysimeter will be checked routinely for liquid in accordance with the facility inspection schedule. If accumulated liquid is present in sufficient quantity to be sampled, it will be analyzed for extractable explosives using USATHAMA methods. In this manner, the subsurface soil surrounding the thermal treatment units and in downwind areas further removed from the treatment area will be assessed on a routine basis.

APPENDIX 4-A
SOIL MONITORING PLAN

SOIL MONITORING PLAN

LIDLAW ENVIRONMENTAL SERVICES (THERMAL TREATMENT), INC.

(FORMERLY R & D FABRICATING AND MANUFACTURING, INC.)

COLFAX, LOUISIANA

LAD981055791

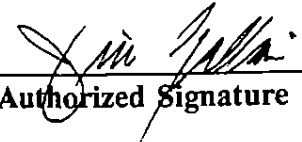
(Revised) July 1993

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(803) 879-3900**

STATEMENT OF CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."



Authorized Signature JIM GALLION

07/16/93

Date

FACILITY MANAGER, LAIDLAW ENVIRONMENTAL SERVICES (THERMAL TREATMENT), INC.
Title

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FIGURE I - SOIL SAMPLING LOCATIONS

APPENDIX A - USATHAMA METHOD FOR ANALYZING TEN EXPLOSIVES BY
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1.0 INTRODUCTION

On March 31, 1993 the Environmental Protection Agency (EPA) issued a RCRA Subpart X and HSWA Permit to R & D Fabricating and Manufacturing, Inc. for the operation of thermal treatment units. The treatment permit was issued subsequent to issuance of a storage permit by the Louisiana Department of Environmental Quality (LDEQ) regulating onsite storage of reactive waste. The full RCRA permit was developed under a joint permitting agreement between the EPA and the LDEQ.

Attachment 15 of the permit contains a Soil Monitoring Plan which addresses how R & D will monitor surface soil in the vicinity of the burner units. Since the permit was drafted, the location of the burn units has been changed slightly to take advantage of better topographic conditions and to better centralize the burn units within the property boundary. In addition, Permit Condition IV.C.7.a) requires that the current monitoring plan be modified to incorporate additional information found in Permit Conditions IV.T.2.(f)-(j) and IV.T.3.(f)-(j).

This revised monitoring plan addresses the additional information requirements and updates the existing plan to reflect actual conditions. The data generated from implementation of this plan can be used to supplement the ongoing environmental assessment over the initial operating period of the facility. This plan is intended to monitor the proposed burn area and will not address the existing burn area, which will be evaluated during closure.

In July 1993, R & D was acquired by Laidlaw Environmental Services (Thermal Treatment), Inc. The new company name is noted on the certification and title page, however; R & D Fabricating and Manufacturing, Inc. is used throughout this document to preserve continuity with the previously submitted Soil Monitoring Plan.

2.0 SAMPLING PROTOCOL

The sampling protocol has been developed to address possible contamination down-wind from the proposed open burning area as a result of particulate fallout. Analytical parameters include metals and organic compounds which may be present in the waste. The ongoing environmental assessment will address this situation through air quality modeling, thus providing an early indication of any potential problems. This sampling protocol is based upon waste constituent data, information already obtained through the trial burn process, and Agency concerns over deposition of heavy metals.

2.1 Constituents of Concern

The Final Technical Support Document for the R & D Thermal Treatment System (ENSR 1991) contains a thorough description of the trial burn and soil sampling results associated with operation of the existing thermal treatment units. Soil samples, including background samples, were collected around the perimeter of the existing burners and were analyzed for extractable explosives as well as Appendix VIII organics and metals. Results showed low levels of HMX and RDX. Also, above background concentrations of eight (8) metals were detected and these metals are considered to be the constituents of greatest concern.

Based upon these results and the constituents in the waste streams handled at the facility, soil samples will be analyzed for the following constituents utilizing the listed method or other approved method:

CONSTITUENT	METHOD
Volatile Organic Compounds	SW-846, 8240
Extractable Explosives (10)	USATHAMA (See App. A)
<u>Total Metals</u>	<u>SW-846 Methods</u>
Arsenic	6010, 7060, 7061
Barium	6010, 7080, 7081

Cadmium	6010, 7130, 7131
Chromium	6010, 7190, 7191
Lead	6010, 7420, 7421
Mercury	7470, 7471
Selenium	6010, 7740, 7741
Silver	6010, 7760, 7761

2.2 Sample Locations and Collection Frequency

The optimum locations for the sampling areas were determined from surface wind direction data compiled at England Air Force Base in Alexandria, Louisiana, a location approximately 15 miles southeast of the R & D facility. Exhibit I contains a wind rose generated from the wind data that was collected from January 1975 through January 1984. The predominate wind directions are from the north during the winter months and south during the summer. The southerly winds predominate and, therefore, emphasis was placed on sample locations to the north of the burner pad.

Figure I shows a total of 12 sample locations which will be used in the soil monitoring plan. Locations 1, 2 and 3 are background samples located in the extreme western portion of the property at 100 foot intervals. The minimal frequency of occurrence of winds from the east-northeast and the distance from the burn area makes this an ideal location for background samples. Locations 4, 5 and 6 are located south of the burn area and are approximately 1000 feet apart. Six sample locations (#7 - #12) have been placed north of the pad in a grid pattern approximately 600 feet apart. These locations will provide good coverage for monitoring of soil in the directions of prevailing winds with regard to the burn area.

Prior to operation of the proposed units, R & D will collect surface samples from all even numbered sample locations noted on Figure I. These samples will be analyzed for the constituents noted in Section 2.1 and the data will be utilized in the development of a background data set for each constituent.

CALMS: 29.7%

NORTH

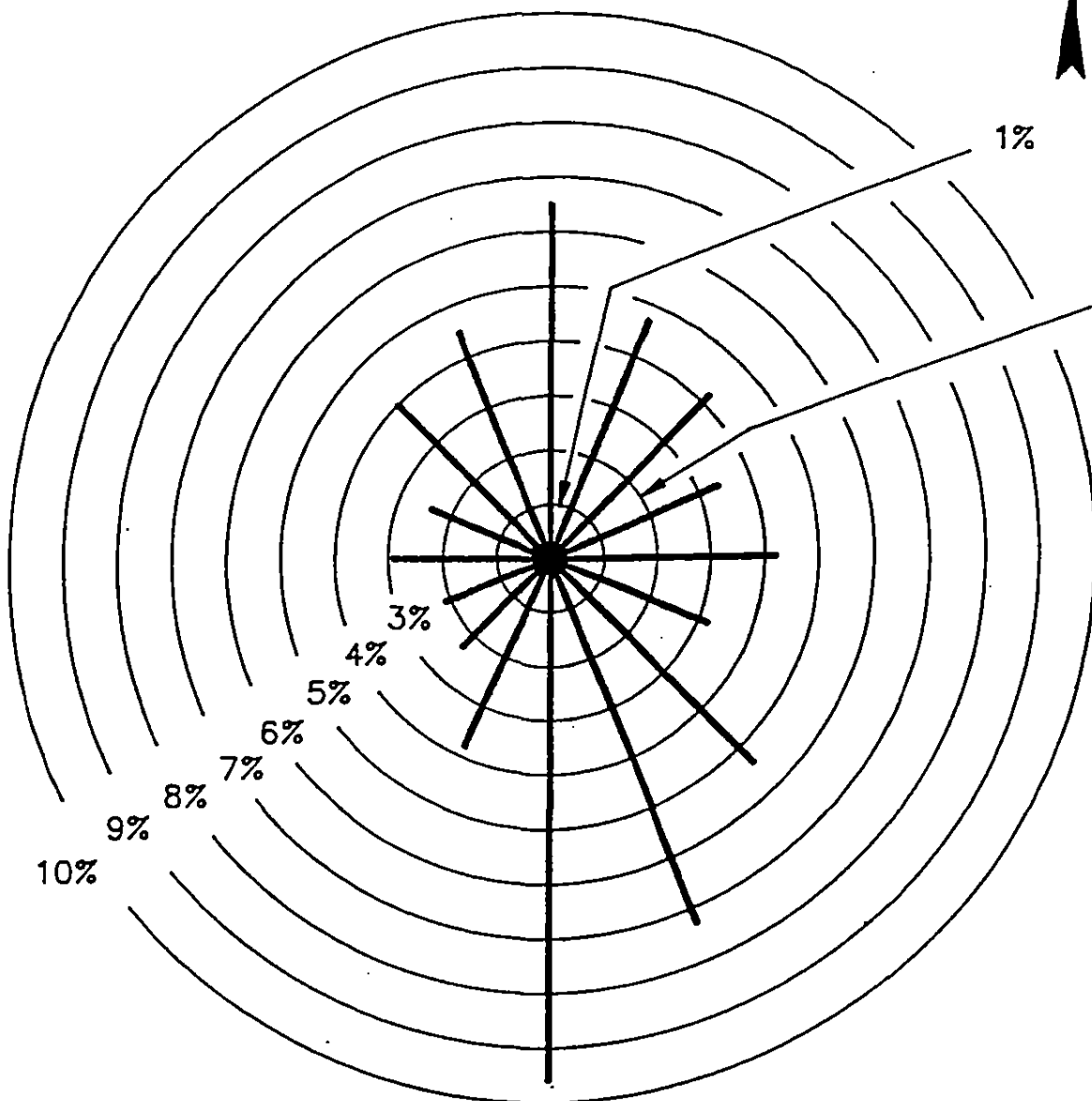


1%

2%

EAST

WEST



SOUTH

SOURCE: GLOBAL CLIMATOLOGY BRANCH,
USAFETAC, AIR WEATHER SERVICE/MAC
ENGLAND AIR FORCE BASE
PERIOD: JAN '75 - JAN '84

PERCENTAGE FREQUENCY
OF WIND DIRECTION



Environmental Technology Engineering, Inc.

SCALE AS SHOWN

DRAWN BY GAH

CHECKED BY RJH

DATE 12-15-89

WIND ROSE

EXHIBIT I

PROJECT NO.

After one (1) year of operation of the proposed burner units, soil samples will be collected from all locations and analyzed for the constituents outlined in Section 2.1. Background data from samples 1, 2 and 3 will be combined with the previous data in order to create a complete background data set for each constituent. Data will be analyzed as discussed in Section 4.1 in order to determine if there is a statistically significant difference between background and burn area concentrations of contaminants. If analytical results indicate that a significant difference exists, the Louisiana Department of Environmental Quality (LDEQ) and the Environmental Protection Agency (EPA) will be notified. A plan to address these results will be developed at that time. If no significant increase is noted, the sampling frequency will be extended to two (2) years.

Surface soil samples will be collected directly from the surface sediments using decontaminated stainless steel spoons or a gloved hand to place the sample into the sample container. Sampling personnel shall wear a separate pair of disposable latex gloves for each sample collected. Sample containers will be prepared by the receiving laboratory and will be used as received from them.

3.0 DATA COLLECTION QUALITY ASSURANCE

For all measurement parameters which have analytical QA objectives listed in the most current EPA or USATHAMA Method, those objectives will be used. Where alternative methods may be used by the contract laboratory, those methods and the QA objectives must meet or exceed standards contained in the EPA or USATHAMA method specified in Section 2.1. Systematic checks utilized by the laboratory will ensure data reliability.

The following information defines quality assurance activities in regard to the following:

- ▶ Strategy - Data Usage and Accuracy
- ▶ Sampling and Field Measurements
- ▶ Sample Analysis

3.1 Quality Assurance Strategy

The data collected from soil sampling and analyses will be used to determine if the thermal treatment units are impacting surface soil within the facility property boundary. If it is determined that surface soil is being impacted, measures can be taken to alleviate or minimize this impact.

The background and burn area analytical results will be analyzed statistically as discussed in Section 4.1. Analytical results for metals will be reported in ppm and for organics, ppb. These levels of detection will allow evaluation of data to determine if a significant difference exists between the background and burn area means.

3.1.1 Data Precision and Accuracy

The terms used in this section which characterize data measurement reliability are defined below:

Accuracy - the degree of agreement of a measurement (or an average of measurements of the same thing) X with an accepted reference or true value, $100 (X-T)/T$, and sometimes expressed as the ratio X/T . Accuracy is a measure of the bias in a system.

Precision - a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. Various measures of precision exist depending upon the "prescribed similar conditions."

Completeness - a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions.

Representativeness - expresses the degree to which data accurately and precisely represent

a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Comparability - expresses the confidence with which one data set can be compared to another.

The precision, or degree of agreement between measurements, is determined by the standard deviation of a single measurement from the mean of the data set. Duplicates of the same sample will be analyzed by the laboratory as a routine precision check. In addition, one duplicate sample per sampling event, selected at random, will be analyzed as a check on sampling and analytical technique.

The accuracy of a sample measurement is reported as percent spike recovery which represents the percentage recovery of a known quantity of compound which is added to the original sample and subsequently analyzed. The methods used in sample analyses will contain quality control audit standards, including sample spiking, to be implemented to ensure data reliability.

3.1.2 Quality Assurance Reports

The contract laboratory will prepare quality assurance documentation for all samples analyzed for each sampling event and will make this documentation available to R & D upon request. The level of detail will be sufficient to document all quality assurance activities specified by the method and shall include but not be limited to:

- Periodic assessment of measurement data accuracy, precision, and completeness;
- Results of performance audits;
- Results of systems audits; and,
- Significant quality assurance problems and resolutions.

A summary of this documentation will be supplied to R & D to be maintained in the data record. Summary information shall include, but not be limited to, percent spike recoveries and the analytical results for duplicate samples.

3.2 Sampling and Field Measurements

Sections 2.0 and 4.0 discuss sample locations, frequency and statistical analysis to be conducted, including rationale for sample locations. The constituents of concern, analytical methods and measures to prevent cross contamination are also addressed. Additional procedures regarding handling of samples are discussed below.

All sample bottle preparation, sample preservation, and maximum holding times shall conform to the procedures described in the analytical method. Sample containers will be prepared by the contract laboratory and will be used as received. The contract laboratory will be responsible for disposing of all samples in accordance with Local, State and Federal regulations.

Sample custody will be documented and maintained for all phases of sampling operations carried out at the facility. The following sections discuss both field and laboratory procedures which will be carried out to ensure the integrity of the sampling effort.

3.2.1 Sample Identification

All samples will be tagged with an identification label which shall be attached directly to the container. At a minimum, the following information will be placed on the label with a waterproof pen.

- Name of Sampling Organization
- Sample Identification Number
- Date

- Time
- Sample Type (i.e., grab, composite)
- Sampling Personnel
- Matrix (May be described by the sample ID #)
- Special Instructions or Precautions

As each sample is collected, a record will be made in the field notebook which further identifies the sample. All samples will be placed in containers and taken to a central staging area where they will be checked and recorded on a chain-of-custody form as described in the following section.

3.2.2 Chain-of Custody Procedures

Chain-of-custody procedures provide documentation of the handling of each sample from the time it is collected until it is destroyed. To maintain a record of sample collection, transfer between personnel, shipment, and receipt and handling by the laboratory, a "Chain-of-Custody Record" will be included with each sample shipment. This document will record pertinent information about each sample included in that shipment. Each time the samples are transferred to another custodian, signatures of the person relinquishing the sample and receiving the sample, as well as the time and date, will document the transfer.

Chain-of-Custody records will have each sample identified with the station number, date and time of collection, matrix, number of containers per station, and analytical constituents. Field forms will include copies so that one copy may be retained while the original and at least one copy are shipped with the samples. The facility manager will retain a copy of the Chain-of-Custody record and keep it in the data record for inspection. If samples are split to different labs, a copy will go to each lab. If additional sheets are required, the person relinquishing the samples is responsible for filling out additional copies, or making reproductions.

The Chain-of-Custody Record will be placed in a protective cover and placed inside the shipping container. All samples will be shipped by the most expedient method to the specified laboratory. Samples will be packed so that no breakage occurs and the shipping container sealed with evidence tape so that any sign of tampering is easily visible.

3.3 Sample Analysis

Chain-of-custody, sample preparation, holding times and analytical procedures have been addressed previously. Additional information regarding sample analysis is provided below.

3.3.1 Instrument Calibration

Each analytical instrument will be calibrated in a manner consistent with EPA calibration protocols and/or the contract laboratory's standard practice. Calibration documentation will be documented in a notebook maintained by the laboratory.

3.3.2 Data Reduction, Validation and Reporting

Data transfer and reduction are essential functions in summarizing information to support conclusions. It is essential that these processes are performed accurately and, in the case of data reduction, accepted statistical techniques are used.

At a minimum, example calculations must be included with the summarized data to facilitate review. The entry of input data and calculations should be checked and the signature or initials of the data technician and reviewer(s) should accompany all data transfers with and without reduction.

Data input and output sheets will be used by the contract laboratory in order to keep track of data. These forms will record all information pertinent to the analytical procedure such as standard curves, QC data, and final results.

For routine analyses, sample response data information will be used to calculate the following as applicable:

1. Quadratic regression line for standards,
2. Coefficient of variation for replicates,
3. Spiked recoveries,
4. Reference sample concentrations, and
5. Sample concentrations.

QC criteria for acceptance will be derived from EPA or the contract laboratory's QC program. The QC criteria will be stored in a data management file for easy retrieval.

If the samples in a sample lot do not pass all the QC checks then the results reported in all samples processed in the same sample set must be considered as suspect and the analyses may need to be repeated. The Laboratory QA Officer will be notified and the necessary corrective action implemented.

The completed batch forms will be stored in files arranged for easy retrieval. Strip charts, copies of parameter notebooks, and QC charts will be stored for each constituent in a project notebook.

The contract laboratory manager will validate a portion of all preliminary data by field group. Example tasks which may be included in the validation review are listed in the following checklist:

1. Were holding times met for each sample?
2. Were samples analyzed using the methods specified in the QA plan?

3. Was a blank run for each batch and properly subtracted from sample?
4. Were the required number of standards and spiked samples analyzed with each batch?
5. Was the correlation coefficient of the calibration curve > 0.995 ?
6. Were spike recoveries within the acceptance criteria stated in the QA Plan?
7. Randomly select one value/batch and trace back through the calculations to the raw data. Do the numbers agree?

3.3.3 Internal Quality Control Checks

The laboratory contracted by R & D will adhere to a strict internal quality control program to assure data quality. Internal quality assurance procedures are designed to assure the consistency and continuity of data. Internal quality assurance procedures include:

- Instrument performance checks
- Instrument calibration
- Documentation on the traceability of instrument standards, samples, and data
- Documentation on analytical and quality control methodology
- Documentation on sample preservation and transportation

Standard analytical quality control will include, but is not limited to:

- Duplicate Samples

At selected stations on a random time frame, duplicate grab samples are collected. This provides a check of sampling technique and precision.

- Split Samples

A representative subsample from the collected sample is removed and both are analyzed for the pollutants of interest. The samples may be reanalyzed or analyzed by two different laboratories for a check of the analytical procedures.

- Spiked Samples

Known amounts of a particular constituent are added to an actual sample or to blanks in concentrations at which the accuracy of the test method is satisfactory. This method provides a proficiency check for the accuracy of the analytical procedures.

If the method allows, one to six compounds with characteristics similar to those being analyzed will be added to every sample prior to extraction. The percent recovery of these compounds is indicative of the efficiency of the analysis at recovering the sample compounds. A sample recovery within the range specified by EPA will be deemed sufficient.

Standards will also be run daily to ensure that numerical data reflects the current sensitivity of the instrument. Prior to any GC/MS analyses, the instrument will be tuned to meet particular specifications.

3.4 System Audits

Two types of audit procedures will be used by the contract laboratory to assess and document performance of project staff--system audits and performance audits. These are performed at frequent intervals under the direction of the Laboratory QA Supervisor.

These audits form one of the bases for corrective action requirements and constitute a permanent record of the conformance of measurement systems to QA requirements.

System audits are inspections of training status, records, QC data, calibrations, and conformance to Standard Operating Procedures without the analysis of check samples. System audits will be performed periodically on laboratory and office operations.

The systems audit protocol is summarized as follows:

1. Laboratory Operations--The Laboratory QA Supervisor will check:

- a. Parameter and/or laboratory notebooks;
- b. Instrument logbooks;
- c. Sample log-in, dispensing, and labeling for analysis;
- d. Updating of QC charts of the spikes; and
- e. Final approval of data from each sample lot.

In addition, the Laboratory QA Supervisor will monitor all experiments to assure complete adherence to approved analytical methods.

2. Final Reports--The Laboratory QA Supervisor will review all final reports and deliverables.

Performance test sample programs administered by various government agencies are also used as a basis for the Laboratory QA Supervisor's performance audit.

4.0 DATA MANAGEMENT

R & D will implement these data management procedures in order to document and track analytical data. These procedures address the data record, the data presentation format, and project file requirements.

4.1 Data Record and Presentation

A data record will be maintained at the facility which contains chain of custody records, analytical results received from the outside laboratory, a statistical evaluation of the data, and a summary presentation of the data in tabular form. This information will be maintained as a distinct unit for each sampling event.

Data received from the laboratory will be required to contain the following information:

- A unique sample identification code which includes the sample location.
- Sampling personnel and date of collection.
- The constituent being analyzed and unit of measure.
- Analytical results with the minimum detection limit.

The sample identification code used for soil samples will identify the matrix, specific location, month and the year as shown in the following example for location 9.

S09-0693

S = soil

09 = location 9

06 = June

93 = 1993

Duplicate samples or additional samples at the same location during each sampling event will have an additional designation as shown:

S09-0693A, S09-0693B, etc.

This unique sample identification code will be used to identify a particular sample on all presentations of the data.

All laboratory data will be summarized in tabular form for each sampling event. For each constituent, the sample identification code and concentration at each location will be noted. Any concentrations recorded as less than the detectable limit will have the lower detectable limit numerical value shown (i.e., < 0.1 mg/kg). The lower detectable limit will be established with the laboratory prior to analyzing the first set of samples and will be in accordance with the method used, subject to possible interferences.

For each constituent, the background data set and the burn area data set generated after one year of operation will be analyzed to determine the arithmetic mean and variance for each. The means for each data set will be compared using the Cochran's Approximation to the Behrens-Fisher Students' t-test as outlined in 40 CFR Part 264, Appendix IV. A one-tail test using a standard t-table at a 0.025 level of significance will be used to compute the critical t value. Values recorded as less than the lower detectable limit numerical value will have that value applied in the statistical analysis.

A data summary showing the t-statistics for each constituent will be prepared in tabular form and maintained in the data record. If a constituent concentration is recorded as less than detectable for all sample locations, it will not be included in the statistical analysis summary table.

In the event that the burn area data set mean exceeds the background mean, additional methods of presenting the data may be used to further assess the data sets. These methods may include graphs showing constituent concentrations at a particular sample location over time or isopleth plots.

4.2 Data Files Maintenance

The analytical laboratory contracted by R & D will maintain data generated from soil analyses in a manner consistent with the particular laboratory's standard practice. Hard copies of the analytical data will be provided to R & D to be placed in the data record. As

stated previously, the data record will also contain chain-of-custody forms, a tabular presentation of the raw data, a statistical evaluation and tabular presentation of the statistical analysis.

In addition to the hard copies contained in the data record, the tabular presentations will be maintained on computer disk. These disks will be maintained at the facility with the data record. Also, the data tables and any summaries related to analytical results will be placed in the facility operating record.

5.0 HEALTH AND SAFETY PLAN

R & D maintains a health and safety plan for all contractors working at the site. This plan, which is located in Appendix B, is comprehensive and provides for the protection of all persons at the facility. Persons conducting soil sampling will not be in close proximity to the burn area and will be minimally exposed to storage areas. There will be no direct exposure to waste and exposure to soil will be minimized through Level D protection and the use of disposable latex gloves.

6.0 PROJECT MANAGEMENT

6.1 Key Personnel

The facility manager, Jim Gallion, will have direct responsibility over implementation of the soil monitoring plan. He will be responsible for securing outside contractors, ensuring that provisions of the health and safety plan are followed, and maintaining data files and records. Mr. Gallion has vast experience in the waste disposal industry including employment as a health and safety officer at a Louisiana hazardous waste treatment facility as well as experience in handling explosive and reactive waste.

Richard Crain, facility operations manager, will share responsibility with the facility manager

to ensure that soil monitoring is implemented at the facility in accordance with this plan. Mr. Crain has been the operations manager at R & D since its inception and is thoroughly familiar with the operation. He has significant experience in handling explosive and reactive waste; environmental affairs; and management.

R & D will employ an outside contractor(s) for sampling and analytical work. These contractors will report directly to the facility manager and operations manager.

6.2 Scheduling

An outside contractor(s) for soil sampling and analysis will be secured at least 30 days prior to initial treatment of waste in the proposed burn units. Prior to initiating thermal treatment, the first round of soil samples will be collected as described in Section 2.0. It is anticipated that samples can be collected in a single day and that analysis can be completed within 45 days. An additional 45 days will be used to develop data tables, evaluate the data statistically and prepare a data summary or other necessary documentation.

After one year of operation, the first complete set of samples will be collected with analytical and data analyses completed within an additional 90 days. Raw data tables will be placed in the operating record for the year that samples were collected. Any reports generated as a result of discrepancies in the background and burn area data sets will be submitted to the LDEQ or the EPA within 30 days after data analyses is complete.

Appendices

APPENDIX A

USATHAMA METHOD FOR ANALYZING TEN EXPLOSIVES BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

Ten Explosives by High Performance Liquid Chromatography

I. SUMMARY

A. Analytes

The following nitro-explosives are quantified:

HMX Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine Cyclo-
tetramethylenetetranitramine
RDX Hexahydro-1,3,5-trinitro-s-triazine Cyclotetramethylene-
tetranitramine
NB Nitrobenzene
1,3-DNB 1,3-dinitrobenzene
1,3,5-TNB .. 1,3,5-trinitrobenzene
2,4-DNT 2,4-dinitrotoluene
2,6-DNT 2,6-dinitrotoluene
TNT 2,4,6-trinitrotoluene
2A,4,6-DNT . 2-amino-4,6-dinitrotoluene
Tetryl A-methyl-N,2,4,6-tetranitroaniline

B. Matrix

This procedure is applicable to the analysis of nitro-explosive compounds in soil and ash.

C. General Method

A fixed amount of acetonitrile is pipetted into a clean vial containing an accurately weighed aliquot of representative soil. The mixture is thoroughly mixed and filtered. The resulting filtrate is analyzed by high performance liquid chromatography (HPLC) and the concentration, in $\mu\text{g/g}$ of soil, for each nitro-explosive is calculated.

II. APPLICATION

A. Calibration Range

HMX 0.5 to 10 $\mu\text{g/ml}$	Tetryl 0.25 to 5 $\mu\text{g/ml}$
RDX 0.5 to 10 $\mu\text{g/ml}$	TNT 0.25 to 5 $\mu\text{g/ml}$
1,3,5-TNB .. 0.25 to 5 $\mu\text{g/ml}$	2A,4,6-DNT .. 0.25 to 5 $\mu\text{g/ml}$
1,3-DNB 0.25 to 5 $\mu\text{g/ml}$	2,6-DNT 0.25 to 5 $\mu\text{g/ml}$
NB 0.25 to 5 $\mu\text{g/ml}$	2,4-DNT 0.05 to 1 $\mu\text{g/ml}$

Test Concentration Range

HMX 2.43 to 48.7 $\mu\text{g/g}$	Tetryl 1.20 to 24.0 $\mu\text{g/g}$
RDX 2.46 to 49.3 $\mu\text{g/g}$	TNT 1.23 to 24.6 $\mu\text{g/g}$
1,3,5-TNB .. 1.25 to 24.9 $\mu\text{g/g}$	2A,4,6-DNT .. 1.24 to 24.8 $\mu\text{g/g}$
1,3-DNB 1.19 to 23.8 $\mu\text{g/g}$	2,6-DNT 1.26 to 25.2 $\mu\text{g/g}$
NB 1.25 to 25.0 $\mu\text{g/g}$	2,4-DNT 0.235 to 4.71 $\mu\text{g/g}$

B. Sensitivity

HMX	0.0735	ng/kilo	count
RDX	0.0611	ng/kilo	count
1,3,5-TNB ...	0.0275	ng/kilo	count
1,3-DNB	0.0207	ng/kilo	count
NB	0.0286	ng/kilo	count
Tetryl	0.0517	ng/kilo	count
2A,4,6-DNT ..	0.0286	ng/kilo	count
2,6-DNT	0.0233	ng/kilo	count
2,4-DNT	0.0396	ng/kilo	count
TNT	0.0178	ng/kilo	count

C. Reporting Limits

Compound in ($\mu\text{g}/\text{gram}$)

HMX	4.08
RDX	3.25
1,3,5-TNB ...	1.51
1,3-DNB	1.36
NB	1.38
Tetryl	10.85
TNT	1.47
2A,4,6-DNT ..	2.23
2,6-DNT	1.44
2,4-DNT	0.329

D. Interferences

1. Any compound that is extracted from the soil with similar retention time and absorbance will cause a high value.
2. Tetryl will break down in the presence of water.

E. Analysis Rate

Approximately eighteen samples could be analyzed in an 8-hour time period. This does not include QA/QC samples.

F. Safety Information

All compounds are potentially explosive. Caution must be exercised in the following areas:

1. Keep all materials cooled and properly stored.
2. Some materials in their pure form need to be stored in water.
3. Do not allow solvents to evaporate.

III. APPARATUS AND CHEMICALS

A. Glassware/Hardware

100 5-ml glass serum vials + teflon septa + aluminum crimp tops
100 12-ml glass vials with teflon lined screw caps
20 10- μ l, 20- μ l, 100- μ l and 500- μ l glass syringes
6 1.0-ml, 2.0-ml, 5.0-ml volumetric pipets
100 1.8-ml autosampler vials with screw caps and teflon septa
100 Lidex LID-X filter syringes with 0.45 μ glass microfiber filter
1 Sonicator
20 Class A 5-ml and 1-ml volumetric flasks

B. Equipment and Operation

1. Analytical System

Perkin Elmer Series 4 HPLC metering and pumping system
Perkin Elmer ISS 100 auto-injector
Perkin Elmer LC95 spectrophotometric detector
Perkin Elmer LCI 100 integrator

2. Chromatographic System

LC 18 guard column 2 cm x 4.6 mm 5- μ
LC 18 column (25 cm long by 4.6 mm inside diameter)

3. Analytical Conditions

a. Auto-injector

15 μ l injection
50 μ l injection loop

b. Metering and Pumping

	Time (min)	Flow (ml/min)	% Acetonitrile	% Methanol	% Water
Equilibrium	0.5	1.0	15	40	45
1.0	13.0	1.0	15	40	45

c. Detector

Wave length - 254 nm
Response time - 5000 milliseconds
Range - 0.5

d. Integrator

Start time - 0.00 min
End time - 20.0 min
Chart speed - 5 mm/min
Attenuation - 8
Offset - 5
Auto zero on
Tic marks on
Start time 4.8 min

e. Retention Times (± 0.15 min)

HMX	5.63 min	Tetryl	12.67 min
RDX	7.29 min	TNT	14.03 min
1,3,5-TNB ...	9.34 min	2A,4,6-DNT ..	14.67 min
1,3-DNB	11.17 min	2,6-DNT.....	15.70 min
NB	12.07 min	2,4-DNT	16.29 min

C. Analytes

	<u>CAS #</u>	<u>Melting Point</u> <u>(°C)</u>	<u>g/cm³</u> <u>Density</u>
HMX	2691-41-0	---	---
RDX	121-82-4	205	1.82 @ 20°C
1,3,5-TNB ...	99-35-04	122.5	1.76 @ 20°C
1,3-DNB	99-65-01	118	1.57 @ 20°C
NB	98-95-3	6	1.205 @ 15°C
Tetryl	---	131	1.57 @ 20°C
2,A,4,6-DNT .	35572-78-2	---	---
2,6-DNT	606-20-2	66	1.28 @ 111°C
2,4-DNT	121-14-2	71	1.32 @ 71°C
TNT	118-96-7	80.1	1.65 @ 20°C

D. Reagents and SARMS

1. Acetonitrile, distilled in glass, HPLC grade.
2. Methanol, distilled in glass, HPLC grade.
3. ASTM Type I water.
4. SARMS, provided by USATHAMA Central QA Lab, as follows:

<u>Compound</u>	<u>Lot Number</u>	<u>% Purity</u>
HMX	1217	99.12
RDX	1130	99.95
1,3,5-TNB ...	1154	99.99
1,3-DNB	2250	99.99
NB	2177	99.76
Tetryl	1149	99.95
2,A,4,6-DNT .	1279	99.99
2,6-DNT	1148	99.99
2,4-DNT	1147	99.98
TNT	1129	99.99

IV. CALIBRATION

A. Initial Calibration

1. Standards

a. Stock Standard

Compound	Lot #	% Purity	Actual Weight (mg)	Final Volume (ml)	Conc ug/ml
HMX	1217	99.12	12.41	5.0	2482
RDX	1130	99.95	11.73	5.0	2346
1,3,5-TNB	1154	99.99	9.895	5.0	1979
1,3-DNB	2250	99.99	9.89	5.0	1978
NB	2177	99.76	10.13	5.0	2026
Tetryl	1149	99.95	9.11	5.0	1822
TNT	1129	99.99	10.06	5.0	2012
2A,4,6-DNT	1279	99.99	9.36	5.0	1872
2,6-DNT	1148	99.99	11.23	5.0	2246
2,4-DNT	1147	99.98	9.34	5.0	1868

All SARMS were accurately weighed to four places directly into a clean, tared 5-ml serum vial. 5 ml of solvent was added to each using a 5-ml volumetric pipet. Those compounds which are stored in water were allowed to air dry prior to weighing.

The stock standard is stored at 0-4°C in a 5-ml serum vial with a teflon septum and crimped seal. The standard can be kept up to three months.

b. Intermediate Standard (ID # 90987-2)

Compound	Conc Stock (ug/ml)	Volume (ml)	Dilution Volume (ml)	Conc ug/ml
HMX	2482	0.400	5	198.6
RDX	2346	0.400	5	187.7
1,3,5-TNB	1979	0.250	5	98.95
1,3-DNB	1978	0.250	5	98.90
NB	2026	0.250	5	101.3
Tetryl	1822	0.270	5	98.39
TNT	2012	0.250	5	100.6
2A,4,6-DNT	1872	0.260	5	97.34
2,6-DNT	2246	0.230	5	103.3
2,4-DNT	1868	0.050	5	18.68

Using glass syringes with an accuracy of $\pm 0.1\%$ aliquots of the stock solutions are transferred to a 5-ml Class A volumetric flask and brought to volume with acetonitrile.

The intermediate standard is stored at 0-4°C in a serum vial with a septum and crimped seal. The intermediate standard can be stored up to 30 days.

c. Calibration Standard

1. ID # 927-05 (0.05 x TRL)

Compound	Parent ID #	Conc Parent ($\mu\text{g/ml}$)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc ($\mu\text{g/l}$)
HMX	90987-2	198.6	0.012	5.0	0.4766
RDX	90987-2	187.7	0.012	5.0	0.4505
1,3,5-TNB	90987-2	98.95	0.012	5.0	0.2374
1,3-DNB	90987-2	98.99	0.012	5.0	0.2374
NB	90987-2	101.3	0.012	5.0	0.2431
Tetryl	90987-2	98.39	0.012	5.0	0.2361
TNT	90987-2	100.6	0.012	5.0	0.2414
2A,4,6-DNT	90987-2	97.34	0.012	5.0	0.2336
2,6-DNT	90987-2	103.3	0.012	5.0	0.2479
2,4-DNT	90987-2	18.68	0.012	5.0	0.0448

The aliquot volume was obtained using a microliter syringe and was diluted to volume in a Class A volumetric flask with a 15% acetonitrile, 40% methanol, and 45% water solution.

2. ID # 927-1 (1.0 x TRL)

Compound	Parent ID #	Conc Parent ($\mu\text{g/ml}$)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc ($\mu\text{g/l}$)
HMX	90987-2	198.6	0.025	5.0	0.9930
RDX	90987-2	187.7	0.025	5.0	0.9385
1,3,5-TNB	90987-2	98.95	0.025	5.0	0.4945
1,3-DNB	90987-2	98.90	0.025	5.0	0.4945
NB	90987-2	101.3	0.025	5.0	0.5065
Tetryl	90987-2	98.39	0.025	5.0	0.4920
TNT	90987-2	100.6	0.025	5.0	0.5030
2A,4,6-DNT	90987-2	97.34	0.025	5.0	0.4867
2,6-DNT	90987-2	103.3	0.025	5.0	0.5165
2,4-DNT	90987-2	18.68	0.025	5.0	0.0934

The aliquot volume was obtained using a microliter syringe and was diluted to volume in a Class A volumetric flask with a 15% acetonitrile, 40% methanol, and 45% water solution.

3. ID # 927-2 (2 x TRL)

Compound	Parent ID #	Conc Parent ($\mu\text{g/ml}$)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc ($\mu\text{g/l}$)
HMX	90987-2	198.6	0.050	5.0	1.986
RDX	90987-2	187.7	0.050	5.0	1.877
1,3,5-TNB	90987-2	98.95	0.050	5.0	0.9895
1,3-DNB	90987-2	98.90	0.050	5.0	0.9890
NB	90987-2	101.3	0.050	5.0	1.013
Tetryl	90987-2	98.39	0.050	5.0	0.9839

Compound	Parent ID #	Conc Parent (µg/ml)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc (µg/l)
TNT	90987-2	100.6	0.050	5.0	1.006
2A,4,6-DNT	90987-2	97.34	0.050	5.0	0.9734
2,6-DNT	90987-2	103.3	0.050	5.0	1.033
2,4-DNT	90987-2	18.68	0.050	5.0	0.1868

The aliquot volume was obtained using a microliter syringe and was diluted to volume in a Class A volumetric flask with a 15% acetonitrile, 40% methanol, and 45% water solution.

4. ID # 927-5 (5 x TRL)

Compound	Parent ID #	Conc Parent (µg/ml)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc (µg/l)
HMX	90987-2	198.6	0.120	5.0	4.766
RDX	90987-2	187.7	0.120	5.0	4.505
1,3,5-TNB	90987-2	98.95	0.120	5.0	2.374
1,3-DNB	90987-2	98.90	0.120	5.0	2.374
NB	90987-2	101.3	0.120	5.0	2.431
Tetryl	90987-2	98.39	0.120	5.0	2.361
TNT	90987-2	100.6	0.120	5.0	2.414
2A,4,6-DNT	90987-2	97.34	0.120	5.0	2.336
2,6-DNT	90987-2	103.3	0.120	5.0	2.479
2,4-DNT	90987-2	18.68	0.120	5.0	0.4483

The aliquot volume was obtained using a microliter syringe and was diluted to volume in a Class A volumetric flask with a 15% acetonitrile, 40% methanol, and 45% water solution.

5. ID # 927-10 (10 x TRL)

Compound	Parent ID #	Conc Parent (µg/ml)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc (µg/l)
HMX	90987-2	198.6	0.250	5.0	9.930
RDX	90987-2	187.7	0.250	5.0	9.385
1,3,5-TNB	90987-2	98.95	0.250	5.0	4.948
1,3-DNB	90987-2	98.90	0.250	5.0	4.945
NB	90987-2	101.3	0.250	5.0	5.065
Tetryl	90987-2	98.39	0.250	5.0	4.919
TNT	90987-2	100.6	0.250	5.0	5.030
2A,4,6-DNT	90987-2	97.34	0.250	5.0	4.867
2,6-DNT	90987-2	103.3	0.250	5.0	5.165
2,4-DNT	90987-2	18.68	0.250	5.0	0.9340

The aliquot volume was obtained using a microliter syringe and was diluted to volume in a Class A volumetric flask with a 15% acetonitrile, 40% methanol, and 45% water solution.

These standards can be stored up to 5 days. They should be kept in a crimp topped 5-ml serum vial with a teflon septum, at 0-5°C.

2. Instrument Calibration

Flow rate should be checked upon initial start-up of the HPLC system (by visually examining the flow rate and checking for any pressure drop), along with other operating parameters i.e. wavelength, mobile phase concentration, pressure drop over the system, to ensure stable conditions.

An initial equilibration time of approximately 15 minutes is recommended.

At the end of the day the HPLC system should be flushed with 100% acetonitrile until a stable pressure drop is observed and then allowed to equilibrate for 15 minutes prior to shut down.

The first analysis of the day is a mobile phase blank to ensure that there are no system interferences.

3. Analysis of Calibration Data

The criteria for acceptability is 1) 10 x TRL $\pm 10\%$ and 2) good recovery of a standard prepared by an independent party from SARM.

a. Standard Criteria

Compound	Lower Limit ($\mu\text{g/l}$)	Upper Limit ($\mu\text{g/l}$)
HMX	8.77	10.71
RDX	8.87	10.85
1,3,5-TNB	4.48	5.48
1,3-DNB	4.28	5.24
NB	4.50	5.50
Tetryl	4.32	5.28
TNT	4.43	5.41
2A,4,6-DNT	4.46	5.46
2,6-DNT	4.59	5.61
2,4-DNT	0.85	1.04

b. Check Standard

Compound	Lot #	Conc ($\mu\text{g/l}$)	Average Pre-Certification Concentration	Upper Limit	Lower Limit
NB	2117	1.100	N/A	1.298	0.902

B. Daily Calibration

1. Standards

a. Stock Standard

Compound	Lot #	% Purity	Actual Weight (mg)	Final Volume (ml)	Conc (µg/ml)
HMX	1217	99.12	12.41	5.0	2482
RDX	1130	99.95	11.73	5.0	2346
1,3,5-TNB	1154	99.99	9.895	5.0	1979
1,3-DNB	2250	99.99	9.89	5.0	1978
NB	2177	99.76	10.13	5.0	2026
Tetryl	1149	99.95	9.11	5.0	1822
TNT	1129	99.99	10.06	5.0	2012
2A,4,6-DNT	1279	99.99	9.36	5.0	1872
2,6-DNT	1148	99.99	11.23	5.0	2246
2,4-DNT	1147	99.98	9.34	5.0	1868

All SARMS were accurately weighed to four places directly into a clean, tared 5-ml serum vial. 5 ml of solvent was added to each using a 5-ml volumetric pipet. Those compounds which are stored in water were allowed to air dry prior to weighing.

The stock standard is stored at 0-4°C in a 5-ml serum vial with a teflon septum and crimped seal. The standard can be kept up to three months.

b. Intermediate Standard (ID # 90987-2)

Compound	Conc Stock (µg/ml)	Volume (ml)	Dilution Volume (ml)	Conc µg/ml
HMX	2482	0.400	5	198.6
RDX	2346	0.400	5	187.7
1,3,5-TNB	1979	0.250	5	98.95
1,3-DNB	1978	0.250	5	98.90
NB	2026	0.250	5	101.3
Tetryl	1822	0.270	5	98.39
TNT	2012	0.250	5	100.6
2A,4,6-DNT	1872	0.260	5	97.34
2,6-DNT	2246	0.230	5	103.3
2,4-DNT	1868	0.050	5	18.68

Using glass syringes with an accuracy of $\pm 0.1\%$ aliquots of the stock solutions are transferred to a 5-ml Class A volumetric flask and brought to volume with acetonitrile.

The intermediate standard is stored at 0-4°C in a serum vial with a septum and crimped seal. The intermediate standard can be stored up to 30 days.

3. Analysis of Calibration Data

The criteria for acceptability of data is $\pm 10\%$ of the peak area found in the initial calibration of the 10 x TRL standard.

4. Calibration Checks

a. Standard Check

% Return on 10 TRL

	Day 1	Day 2	Day 3	Day 4
HMX				
Initial	98.28	104.26	104.51	106.84
Final	104.26	105.48	106.84	105.63
RDX				
Initial	98.87	98.87	101.50	101.52
Final	98.78	104.28	101.52	105.04
1,3,5-TNB				
Initial	98.94	99.56	99.02	100.99
Final	99.56	99.38	100.99	101.83
1,3-DNB				
Initial	99.17	98.36	99.01	101.70
Final	98.36	102.22	101.70	100.87
NB				
Initial	99.09	98.57	99.94	101.95
Final	98.57	99.94	101.95	101.14
Tetryl				
Initial	95.57	41.15	0	0
Final	41.15	27.20	0	53.6*
2A,4,6-DNT				
Initial	99.60	94.45	101.14	102.69
Final	94.45	101.52	102.69	96.12
2,6-DNT				
Initial	99.20	97.73	99.27	101.42
Final	87.73	100.12	101.42	101.33
2,4-DNT				
Initial	99.26	95.10	98.46	99.49
Final	95.10	97.21	99.49	97.76

*Fresh solution prepared.

b. Check Standard

% Return on 10 TRL

	Day 1	Day 2	Day 3	Day 4
NB				
Initial	99.80	93.87	90.52	84.93
Final	93.87	89.06	84.93	89.60

NOTE: Check standard was made by diluting a stock standard prepared by a qualified independent party from a USATHAMA SARM.

V. CERTIFICATION TESTING

A. Soil Spiking

- 36 aliquots of ~2 grams of USATHAMA standard soil were weighed out in clean, tared 5-ml serum vials and the weight recorded to the nearest 0.001 gram.
- The vials were labelled as follows:

Group I	Group II	Group III	Group IV	Group V	Group VI
D1-HP-00	D1-HP-0.5	D1-HP-1	D1-HP-2	D1-HP-5	D1-HP-10.0
D2-HP-00	D2-HP-0.5	D2-HP-1	D2-HP-2	D2-HP-5	D2-HP-10.0
D3-HP-00	D3-HP-0.5	D3-HP-1	D3-HP-2	D3-HP-5	D3-HP-10.0
D4-HP-00	D4-HP-0.5	D4-HP-1	D4-HP-2	D4-HP-5	D4-HP-10.0
D5-HP-00	D5-HP-0.5	D5-HP-1	D5-HP-2	D5-HP-5	D5-HP-10.0
D6-HP-00	D6-HP-0.5	D6-HP-1	D6-HP-2	D6-HP-5	D6-HP-10.0

- The following solution #092787-1 was used for spiking the soils.

Compound Name	Conc. of Parent Sol'n. ng/μl	Aliq. Vol. (ml)	Final Vol. (ml)	Final Conc. ng/μl
HMX	2482	0.7	5.0	347.5
RDX	2346	0.75	5.0	351.9
1,3,5-TNB	1979	0.45	5.0	178.1
1,3-DNB	2020	0.42	5.0	169.7
NB	2882	0.31	5.0	178.7
Tetryl	1822	0.47	5.0	171.3
TNT	2012	0.44	5.0	177.1
2A,4,6-DNT	1872	0.47	5.0	176.0
2,6-DNT	2246	0.40	5.0	179.7
2,4-DNT	1868	0.09	5.0	33.62

C. Calibration Standard

1. ID # 927-10 (10 x TRL)

Compound	Parent ID #	Conc Parent (µg/ml)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc (µg/l)
HMX	90987-2	198.6	0.250	5.0	9.930
RDX	90987-2	187.7	0.250	5.0	9.385
1,3,5-TNB	90987-2	98.95	0.250	5.0	4.948
1,3-DNB	90987-2	98.90	0.250	5.0	4.945
NB	90987-2	101.3	0.250	5.0	5.065
Tetryl	90987-2	98.39	0.250	5.0	4.919
TNT	90987-2	100.6	0.250	5.0	5.030
2A,4,6-DNT	90987-2	97.34	0.250	5.0	4.867
2,6-DNT	90987-2	103.3	0.250	5.0	5.165
2,4-DNT	90987-2	18.68	0.250	5.0	0.9340

The aliquot volume was obtained using a microliter syringe and was diluted to volume in a Class A volumetric flask with a 15% acetonitrile, 40% methanol, and 45% water solution.

Shelf life is 5 days if stored at 0-4°C.

2. Instrument Calibration

Flow rate should be checked upon initial start-up of the HPLC system (by visually examining the flow rate and checking for any pressure drop), along with other operating parameters i.e. wavelength, mobile phase concentration, pressure drop over the system, to ensure stable conditions.

An initial equilibration time of approximately 15 minutes is recommended.

At the end of the day the HPLC system should be flushed with 100% acetonitrile until a stable pressure drop is observed and then allowed to equilibrate for 15 minutes prior to shut down.

The first analysis of the day is a mobile phase blank to ensure that there are no system interferences.

1. Blank
2. 10 x TRL #927-10
3. Blank
4. Check STD
5. Blank
6. Sample
7. Sample

End of day

8. 10 x TRL #927-10
9. Blank
10. Check Std

4. Spike the samples as follows:

	Group I 00 μ l Spike	Group II 14 μ l Spike	Group III 28 μ l Spike	Group IV 56 μ l Spike	Group V 140 μ l Spike	Group VI 280 μ l Spike
HMX	0.0	4.87	9.73	19.46	48.65	97.30
RDX	0.0	4.93	9.85	19.71	49.27	98.53
1,3-DNB	0.0	2.49	4.99	9.87	24.93	49.87
1,3,5-TNB	0.0	2.38	4.75	9.50	23.76	47.52
NB	0.0	2.50	5.00	10.01	25.02	50.04
Tetryl	0.0	2.40	4.80	9.59	23.98	47.96
TNT	0.0	2.48	4.96	9.92	24.79	49.59
2A,4,6-DNT	0.0	2.46	4.93	9.86	24.64	48.28
2,6-DNT	0.0	2.52	5.03	10.06	25.16	50.32
2,4-DNT	0.0	0.471	0.941	1.88	4.71	9.41

- These values are the total μ g of each compound spiked onto the 2-gram aliquots of USATHAMA standard soil.
- The soil was spiked by injecting the appropriate volume indicated in each group of the intermediate standard 092787-1 directly on to the weighed soil in the 10-ml vial with a microsyringe.
- The solvent was evaporated from the soil using a stream of helium to gently blow the solvent off. The soil was allowed to set 1 hour before extraction solvent was added.

B. Soil Extraction

- To each vial with the weighed and spiked soil, 5 ml of acetonitrile was accurately pipetted and capped securely with a crimped top and teflon septum.
- The solution was vigorously shaken by hand for 5 seconds to assure that all the soil surface areas were wetted.
- The vials containing the soil and extract were placed so that they did not touch and were suspended approximately 0.25 inches above the sonication head in the cup horn attachment for the sonicator. The solutions were sonicated for 10 minutes at a power control knob setting of 7 after tuning. The sonicating bath was maintained at a temperature of less than 120°F.
- The soil and solvent were shaken thoroughly and then separated by centrifuging for 5 minutes at 200 rpm.
- An aliquot was taken from the vial and filtered through a 0.45-micron glass fiber using a syringe filtration system.

6. 400 μ l of filtrate was transferred to an autosampler vial to which 400 μ l of MeOH and water solution (20% MeOH + 80% H₂O) was added.

C. Analysis by HPLC

<u>Day I</u>	<u>Day II</u>	<u>Day III</u>	<u>Day IV</u>
Blank	Blank	Blank	Blank
Check STD	10 x TRL	10 x TRL	10 x TRL
Blank	Blank	Blank	Blank
0.50 x TRL	Check STD	Check STD	Check STD
1 x TRL	Blank	Blank	Blank
2 x TRL	D2-HP-00	D3-HP-00	D4-HP-00
5 x TRL	D2-HP-0.5	D3-HP-0.5	D4-HP-0.5
10 x TRL	D2-HP-1	D3-HP-1	D4-HP-1
Blank	D2-HP-2	D3-HP-2	D4-HP-2
D1-HP-00	D2-HP-5	D3-HP-5	D4-HP-5
D1-HP-0.5	D2-HP-10	D3-HP-10	D4-HP-10
D1-HP-1	Blank	Blank	Blank
D1-HP-2	10 x TRL	10 x TRL	10 x TRL
D1-HP-5	Blank	Blank	Blank
D1-HP-10	Check STD	Check STD	Check STD
Blank			
10 x TRL			
Blank			
Check STD			

VI. SAMPLE HANDLING & STORAGE

A. Sampling Procedure

1. Field

Field sampling will be performed by inserting stainless steel shelby tube into the processed soil in the bucket of the front end loader at regular pre-determined intervals. The processed soil core collected will be sealed in the tube by covering both ends with aluminum caps and stored in a secure repository.

The shelby tubes will be collected from the repository on a routine basis which will not exceed 24 hours and taken to the laboratory.

2. Laboratory

In the laboratory, equal weights of soil, free of rocks and extraneous material, will be taken from the end of each tube for the 24-hour sampling period and will be composited together. The weight from each tube will vary depending on the number of tubes collected, but it will be enough to give a final composite weight of 200 grams.

a. Dry Brittle Soils

If the samples are dry and brittle, then each weighed aliquot will be broken up and placed in a clean glass container. The glass container will contain a volume in excess of the amount of soil to be added and sealed with a teflon lined screw cap. The jar will be shaken and/or stirred until its contents are homogenous.

An initial sub-sample will be taken for analysis. A second sub-sample will be used to fill a labelled 40-ml glass vial with a teflon lined screw cap. The glass vial will be archived in a refrigerator at 4°C.

b. Moist Cohesive Soils

If the samples are moist and cohesive then each weighed sample will be placed in a clean stainless steel round-bottom bowl. The material will be thoroughly mixed and sub-divided by hand until it is mixed uniformly.

An initial sub-sample will be taken for analysis. A second sub-sample will be used to fill a labelled 40-ml glass vial with a teflon lined screw cap. The glass vial will be archived in a refrigerator at 4°C.

B. Container

Stainless steel shelby tubes with aluminum caps
500-ml, amber, wide-mouth jars with teflon lined screw caps
40-ml, amber glass vials

C. Storage Conditions

1. Field

A secure and tightly sealed repository box with an opening that allows the tubes to be dropped in as they are collected. The box will be at ambient temperature.

2. Laboratory

Sample storage after compositing will be in a refrigerator at 4°C.

D. Holding Times

Samples are to be extracted within seven days of sampling and analyzed within 30 days of extraction.

E. Solution Verification

A control reference standard will be made in a separate lab by qualified individuals who are not involved in the project from USATHAMA supplied SARMS.

VII. PROCEDURE

A. Soil Extraction

1. Soil (0.25 grams for feed pile, 2 grams for processed soil) is weighed to the third decimal and placed in a glass serum vial.
2. To each vial with the weighed and spiked soil, 5 ml of acetonitrile was accurately pipetted and capped securely with a crimped top and teflon septum.
3. The solution was vigorously shaken by hand in order to assure that all soils were wetted.
4. The vials containing the solutions were placed in a water bath so that they did not touch, and were suspended approximately 0.25 inches above the sonication head in the cup horn attachment. The solutions were sonicated for 10 minutes at a power control setting of 7 after proper tuning. The sonicating bath was maintained at a temperature of less than 120°F.
5. The sonicated solution was thoroughly shaken and then separated by centrifuging for 5 minutes at 2000 rpm.
6. An aliquot was taken from the vial and filtered through a 0.45-micron glass fiber using a syringe filtration system.
7. 400 μ l of filtrate was transferred to an autosampler vial to which 400 μ l of MeOH and water solution (20% MeOH + 80% H₂O) was added.

B. Chemical Reactions

There are no compound modifications or derivatizations in this method.

C. Instrumental Analysis

1. Analytical System

Perkin Elmer Series 4 HPLC metering and pumping system
Perkin Elmer ISS 100 auto-injector
Perkin Elmer LC95 spectrophotometric detector
Perkin Elmer LCI 100 integrator

2. Chromatographic System

LC 18 guard column Supelco 2 cm x 4.6 mm 5- μ
LC 18 column (25 cm long by 4.6 mm inside diameter) 5- μ

3. Analytical Conditions

a. Auto-injector

15 μ l
50 μ l injection loop

b. Metering and Pumping

	Time (min)	Flow (ml/min)	% Acetonitrile	% Methanol	% Water
Equilibrium	0.5	1.0	15	40	45.
Analysis Run	13.0	1.0	15	40	45

Pressure drop = ~14.3 mpa.

c. Detector

Wave length - 254 nm
Response time - 5000 milliseconds
Range - 0.5

d. Integrator

Start time - 0.00 min
End time - 20.0 min
Chart speed - 5 mm/min
Attenuation - 8
Offset - 5
Auto zero on
Tic marks on
Start time 4.8 min

VIII. CALCULATION

$$\text{Conc } \mu\text{g/g} = \frac{10B}{W}$$

Where B = concentration in $\mu\text{g/ml}$ as obtained from the calibration curve
using peak areas

W = weight of soil in grams

10 = 2 (dilution factor) x 5 ml

Concentration is expressed in $\mu\text{g/g}$ wet weight.

IX. DAILY QUALITY CONTROL

A. Control Samples

1. Stock Standard

Compound	Lot #	% Purity	Actual Weight (mg)	Final Volume (ml)	Conc $\mu\text{g/ml}$
HMX	1217	99.12	12.41	5.0	2482
RDX	1130	99.95	11.73	5.0	2346
1,3,5-TNB	1154	99.99	9.895	5.0	1979
1,3-DNB	2250	99.99	9.89	5.0	1978
NB	2177	99.76	10.13	5.0	2026

Compound	Lot #	% Purity	Actual Weight (mg)	Final Volume (ml)	Conc $\mu\text{g/ml}$
Tetryl	1149	99.95	9.11	5.0	1822
TNT	1129	99.99	10.06	5.0	2012
2A,4,6-DNT	1279	99.99	9.36	5.0	1872
2,6-DNT	1148	99.99	11.23	5.0	2246
2,4-DNT	1147	99.98	9.34	5.0	1868

All SARMS were accurately weighed to four places directly into a clean, tared 5-ml serum vial. 5 ml of solvent was added to each using a 5-ml volumetric pipet. Those compounds which are stored in water were allowed to air dry prior to weighing.

The stock standard is stored at 0-4°C in a 5-ml serum vial with a teflon septum and crimped seal. The standard can be kept up to three months.

2. Intermediate Standard

Compound	Conc Stock ($\mu\text{g/ml}$)	Volume (ml)	Dilution Volume (ml)	Conc $\mu\text{g/ml}$
HMX	2482	0.700	5.0	347.5
RDX	2346	0.750	5.0	351.9
1,3,5-TNB	1979	0.450	5.0	178.1
1,3-DNB	1978	0.450	5.0	178.0
NB	2026	0.450	5.0	182.3
Tetryl	1822	0.500	5.0	182.2
TNT	2012	0.450	5.0	181.1
2A,4,6-DNT	1872	0.500	5.0	187.2
2,6-DNT	2246	0.400	5.0	179.7
2,4-DNT	1868	0.090	5.0	33.62

Using glass syringes with an accuracy of $\pm 0.1\%$ aliquots of the stock solutions are transferred to a 5-ml Class A volumetric flask and brought to volume with acetonitrile.

The intermediate standard is stored at 0-4°C in a serum vial with a septum and crimped seal. The intermediate standard can be stored up to 30 days.

3. 10 CRL

Compound	Conc Parent ($\mu\text{g/ml}$)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc ($\mu\text{g/l}$)
HMX	347.5	0.35	5.0	24.3
RDX	351.9	0.35	5.0	24.6
1,3,5-TNB	178.1	0.35	5.0	12.5
1,3-DNB	170.0	0.35	5.0	11.9

Compound	Conc Parent ($\mu\text{g/ml}$)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc ($\mu\text{g/l}$)
NB	178.7	0.35	5.0	12.5
Tetryl	171.4	0.35	5.0	12.0
TNT	177.1	0.35	5.0	12.4
2A,4,6-DNT	175.7	0.35	5.0	12.3
2,6-DNT	179.7	0.35	5.0	12.6
2,4-DNT	33.62	0.35	5.0	2.35

The aliquot volume was obtained using a microliter syringe and was diluted to volume in a Class A volumetric flask with a 21% acetonitrile, 35% methanol, and 44% water solution.

4. 2 CRL

Compound	Conc Parent ($\mu\text{g/ml}$)	Aliquot Volume (ml)	Final Volume (ml)	Final Conc ($\mu\text{g/l}$)
HMX	347.5	0.075	5.0	5.21
RDX	351.9	0.075	5.0	5.28
1,3,5-TNB	178.1	0.075	5.0	2.67
1,3-DNB	170.0	0.075	5.0	2.55
NB	178.7	0.075	5.0	2.68
Tetryl	171.4	0.075	5.0	2.57
TNT	177.1	0.075	5.0	2.66
2A,4,6-DNT	175.7	0.075	5.0	2.64
2,6-DNT	179.7	0.075	5.0	2.70
2,4-DNT	33.62	0.075	5.0	0.504

B. Control Charts

1. Description of Charts to be Maintained

Single day \bar{X} -R control charts are prepared for each control analyte using data from the duplicate spiked QC samples in each lot to determine percent recovery:

$$\frac{\text{Found Concentration}}{\text{Spiked Concentration}} \times 100$$

Use of percent recovery allows for minor variations in spiking solution concentrations.

To prepare control charts, the analyst should have access to the following data:

- Percent recovery of each analyte in the two high concentration spiked QC samples (Class 1).
- Average (\bar{X}) percent recovery for the two spiked QC samples (Class 1) in each lot.

- Difference (R) between the percent recoveries for the two spiked QC samples (Class 1) in each lot.

The initial control chart shall be prepared using the four days of certification data closest to the spiking concentration used during analyses. The average \bar{X} (\bar{X}), average range (R), and control limits for \bar{X} and R shall be updated after each in-control lot for the first 20 lots. Limits established after lot 20 shall be used for the next 20 lots. Control charts shall be updated after each 20 lots, thereafter, using the most recent 40 points.

Three-point moving average control charts shall be maintained for each control analyte spiked in the single low concentration spiked QC sample (Class 1), single high sample (Class 1A), or the additional spiked QC sample for extended ranges. The \bar{X} -R three-point moving average control chart shall be constructed for each control analyte as follows:

- Use percent recovery to allow for minor variations in spiking concentration.
- The first plotted point is the average of the first three recoveries (from certification, at concentrations nearest the spiking level).
- Subsequent points are obtained by averaging the three most recent individual recovery values (outliers excluded from calculation, but not from plot).
- The range for each point is the difference between the highest and lowest value for each group of three values.

2. Initial Warning and Control Limits from Certification Data (% Recovery)

	Mean (\bar{X})	Warning Limit ($\bar{X} \pm$)	Control Limit ($\bar{X} \pm$)
HMX			
10 x CRL	93.37	2.64	3.97
2 x CRL	91.60	42.72	64.24
RDX			
10 x CRL	85.35	0.59	0.88
2 x CRL	74.80	5.97	8.97
TNB			
10 x CRL	92.54	0.60	0.91
2 x CRL	107.63	16.62	25.0

	Mean (\bar{X})	Warning Limit ($\bar{X} \pm$)	Control Limit ($\bar{X} \pm$)
DNB			
10 x CRL	100.71	2.19	3.30
2 x CRL	105.88	9.59	17.02
NB			
10 x CRL	87.45	4.00	6.02
2 x CRL	87.79	6.20	9.32
Tetryl			
10 x CRL	141.04	7.26	10.93
2 x CRL	116.42	33.44	50.29
TNT			
10 x CRL	87.85	3.47	5.51
2 x CRL	95.31	7.61	11.45
2,A,4,6-DNT			
10 x CRL	87.89	3.86	5.81
2 x CRL	95.79	19.46	29.26
2,6-DNT			
10 x CRL	88.59	1.61	2.43
2 x CRL	89.24	7.93	11.92
2,4-DNT			
10 x CRL	98.65	0.56	0.83
2 x CRL	93.88	5.60	8.43

NOTE: These values are calculated based upon the single day \bar{X} -R control charts calculations from Section J of the USATHAMA QA Manual.

X. REFERENCES

A. USATHAMA, Method 8H, 1983.

IX. DATA

A. Off-The-Shelf Reference Materials

No off-the-shelf reference materials are used in this procedure. All reference materials are SARMS supplied by USATHAMA.

APPENDIX B
SITE HEALTH AND SAFETY PLAN

LIDLAW ENVIRONMENTAL SERVICES (THERMAL TREATMENT), INC.
COLFAX, LOUISIANA

VISITOR/CONTRACTOR SITE HEALTH AND SAFETY POLICY

Laidlaw Environmental Services (Thermal Treatment), Inc., operates an explosive/reactive hazardous waste thermal treatment facility, which meets the needs of industrial and commercial generators. Prior to acceptance, each waste stream is carefully reviewed and analyzed. All wastes stored at the facility are maintained in sealed containers approved by the Department of Transportation (DOT) for that specific material. Over the years, Laidlaw has established a sound track record in regards to compliance and safety.

General Classes of Waste

Waste received by Laidlaw Environmental Services (Thermal Treatment), Inc., is classified by the EPA as explosive/reactive and by DOT as explosive, reactive, flammable.

1. Ignitability:
A characteristic of a substance, such as, but not limited to, alcohol, which may cause such substance to ignite and burn readily if not properly handled.
2. Reactivity:
A characteristic of a substance, such as, but not limited to, by-products of explosives, which may cause such substance to explode or generate harmful gases if not properly handled.

Associated Risks

Even though all waste brought into Laidlaw facilities are packaged according to latest government accepted standards, the materials should still be treated carefully. Safe handling and maintaining a safety-minded attitude minimizes almost all of the risks associated with the operation of an explosive/reactive treatment business.

Notwithstanding due care and safety procedures, risks associated with the waste exist. Flammable waste produce vapors, which can cause effects on the body and which sometimes present an inhalation hazard. Explosive/reactive wastes can decompose, and under certain conditions, cause a violent fire or explosion.

First Aid Procedures For Exposure

Should an incident arise where a visitor/contractor is exposed or injured, prompt first aid in the first minutes of contact is essential, if not life saving. If a visitor believes he is being overcome by smoke, vapor, etc., he should move to an area of fresh air immediately, and inform both supervisor and a Laidlaw representative of the problem. If a visitor's eyes come into contact with chemicals, their eyes should be flushed with water immediately for at least 30 minutes. If chemicals contact the skin, the affected area should be rinsed for 15 minutes. If anyone receives first aid for an exposure, he must see a physician to check for any further effects.

General Safety Rules

1. All visitors/contractors must sign in and out daily.
2. Smoking, eating or drinking shall be limited to designated areas.
 - a. Food and drinks may be consumed ONLY in designated break areas. Do not litter.
 - b. A smoking area has been designated outside the administrative office building. Other smoking areas may be designated with the approval of the Facility Manager. Ashes and cigarette butts are to be disposed of ONLY in the containers provided.
3. Absolutely no person(s) under the influence or in possession of any controlled substances or alcoholic beverages or firearms will be allowed on the premises.
4. All visitors/contractors shall remain in the specified work area unless Laidlaw gives specific permission otherwise.

The restrooms in the office area may be utilized.

At no time is a visitor/contractor allowed to be in the explosive/reactive area without a Laidlaw personnel escort.

5. Laidlaw equipment shall only be operated by Laidlaw personnel.
6. Appropriate safety equipment, such as eye protection, must be worn.
7. INAPPROPRIATE BEHAVIOR, UNSAFE ACTS OR VIOLATION OF LAIDLAW SAFETY RULES WILL RESULT IN THE IMMEDIATE EXPULSION OF THE VIOLATOR FROM LAIDLAW PROPERTY.

8. A copy of Laidlaw Environmental Services procedure SAF-05-0, Contractor Safety Requirements, along with Employee Health & Safety Rules is attached as part of this policy for additional guidance.

Personal Safety

A certain amount of responsibility must be assumed by the visitor concerning his personal safety. After each work shift and before eating or drinking, the worker should wash in order to avoid possible contamination. Most importantly, personal safety at Laidlaw entails using commons sense before attempting any job or task. If you have a question, ask first, then act.

Agreement

I acknowledge and agree, as of this ____ day of _____, 19____, that I have read, understand and will comply with the "Visitor/Contractor Site Health and Safety Policy" for Laidlaw Environmental Services (Thermal Treatment), Inc.

Visitor: _____
(Print Name) (Signature)

Company Name: _____

Witnessed by: _____
(Print Name) (Signature)

Attachments (17)

PREPARED BY	APPROVED BY	TITLE	DATE	EFFECTIVE DATE:
W. Hetrick	P. Jennings	Mgr, H & S	10/08/90	01/02/91
	R. Davis	VP, Ext. Affairs	10/08/90	REVIEW DATE: 01/02/92
				SUPERCEDES: N/A

I. PURPOSE

The following requirements apply to all general contractors and sub-contractors at Laidlaw Environmental Services' facilities, as well as any project or activity for which Laidlaw Environmental is responsible, (such as field services, remediation projects, etc). Additional facility or project specific safety requirements may exist due to the nature of the work (e.g. Laidlaw Environmental Health and Safety Rules for Employees). Questions related to compliance with these standards should be addressed to the Laidlaw representative and Regional/Facility Health and Safety working with each contractor before project start-up.

II. RESPONSIBILITY**A. Facility Management**

1. It is the responsibility of facility management (or Laidlaw Project Manager) for work at non-Laidlaw sites to assure that notification and compliance with these requirements is accomplished. A pre-project startup Health and Safety review is required for each project regardless of prior work experience with a contractor or other personnel.

B. Health and Safety

1. Health and Safety will develop and assist in the review of site health and safety plans with contractors. Health and Safety will also audit the performance of contractors. If compliance with Laidlaw requirements and applicable regulations is not maintained, Health and Safety will be responsible to take appropriate action which may include stopping the project until resolution of the items of concern is achieved.

III. REQUIREMENTS

A. Accidents/Injuries:

1. All personal injury and property damage shall be reported to the Laidlaw representative working with the contractor as soon as possible. A contractor's written report must be submitted within twenty-four hours to the facility manager. This report should identify the cause of the incident as well as corrective action to prevent recurrence. The Laidlaw "Supervisors Report of Injury" form may be used by the contractor.

B. Alcohol/Drugs/Weapons/Explosives:

1. Alcoholic beverages, illegal drugs, narcotics, weapons of any kind or ammunition (with the exception of required tools such as utility knives) are not permitted on Laidlaw property. Personnel possessing, using or distributing any of the above will be removed from the premises. Individuals under the influence of illegal drugs, an unauthorized substance or alcohol shall not be allowed on Laidlaw property. When specified in the facility or project safety and health plan, drug and alcohol screening tests will be required of individuals prior to project start-up. Failure to pass these tests will be cause for denial to the project.
2. Any use of explosives by the contractor or the contractor's employee(s) without prior approval by the Laidlaw representative is prohibited.

C. Approvals:

1. The Contractor shall be required to obtain all pertinent work permits or authorizations from the Laidlaw representative or other agencies as required. Specific approval by the Laidlaw representative must be obtained before beginning any of the following:
 - a. Work on existing pipelines or equipment.
 - b. Entering tanks, vessels or confined spaces.
 - c. Entering any designated high-hazard areas or waste management units.
 - d. Using torches, electrodes, open flames, or any device which could produce sparks, ignition sources, or fire.
 - e. Closing walkways, roads, or restricting traffic.
 - f. Starting excavations.
 - g. Backfilling excavations.

F. Horseplay/Irresponsible Behavior:

1. Horseplay, distracting others, operating equipment in an unsafe manner, endangering the safety or welfare of another, taking chances by not following instructions or safety procedures will be cause for immediate removal from the site.

G. Medical Requirements:

1. When work with hazardous materials, substances or waste requires medical examinations prior to project start-up, the contractor will provide documentation that the site or project medical surveillance requirements have been met.

H. OSHA Record of Injuries and Illnesses:

1. At the request of Laidlaw Health and Safety copies of the OSHA 200 log will be provided for review by the contractor. A poor Safety and Health record reflected by the contractor may place certain conditions upon the contractor and his employees such as additional training, standard operating procedures to be developed, safety equipment to be utilized, etc. Poor safety performance on the project may be cause for discontinuance of the project and related work until adequate safeguards and assurances can be provided that safe workplace conditions will be maintained.

I. Personal Protective Equipment:

1. All personal protective equipment (PPE) to be used by contractor employees shall be provided by the contractor. The facility or project health and safety plan will specify the PPE required and approved by Laidlaw Health and Safety.

J. Restricted Areas/Security:

1. All contractors will enter and exit Laidlaw property only at those locations designated for their use. All breaks and lunch periods will be taken at those locations designated by the Laidlaw representative.
2. All contractors and their employees must observe all facility requirements with respect to restricted areas or restricted access. Unless identified otherwise, all waste management units are restricted areas and access is not permitted without prior approval by the Laidlaw representative.

3. All vehicles entering or leaving Laidlaw property are subject to inspection. Vehicles may be inspected on a random basis at any time by the security representative. The driver will be detained if company property is found until facility management is contacted.

K. Safety Briefings:

1. All contractors are required to provide job safety briefings to their employees during the course of the project. This may vary in length from several minutes to considerably longer periods of time based on the risks the contractor has identified (or has been alerted to by Laidlaw Health and Safety.)
2. These worksite briefings may follow the format of the Job Safety Briefing used by Laidlaw supervision or any acceptable format which documents attendance by the contractor's employees. At a minimum these Job Safety Briefings will be conducted prior to project start-up and at the least weekly thereafter. The nature of the project may require more frequent meetings. (For example, daily before each work shift begins.)

L. Speed Limits:

1. The speed limit on site is 10 mph and may not be exceeded unless it has been clearly posted otherwise.
2. Specific work projects may, with appropriate approval, permit modification. Only Regional/Facility Health and Safety has the authority to modify site speed limit controls.

M. Training:

1. Employee training for work with hazardous materials, substances or wastes must be in accordance with state and federal safety and health regulations as well as any applicable permit requirements specified for the project. When requested by Health and Safety, records of such training will be provided for Laidlaw review. Certain training records may be a pre-requisite for contract approval.
2. Equipment operators (trucks, fork-lifts, dozers, excavators, cranes, etc.) must be capable of producing validated certificates, credentials or licenses as appropriate for the equipment they are responsible for operating. Operators of equipment who have not received acceptable training, instruction and/or licensing will not be permitted to operate on site.

N. Vehicle Safety:

1. All vehicles must be parked in areas designated for contractors. No private vehicles are permitted on site without Laidlaw approval. There will be no passing of moving vehicles at job sites. Vehicles will only be operated by personnel with valid licenses and good driving records. Vehicles shall have all required inspection and operating permits.
2. Seat belts are mandatory and shall be used. Vehicle operators not using seat belts will not be allowed on site. Vehicles without seat belts will not be permitted on site.
3. Vehicle operations which violate speed limits, operation requirements or other procedures will be cause for immediate removal of the operator from the site.

IV. REFERENCES

Title 29, Code of Federal Regulations, Parts 1910 and 1926

V. APPENDICES

None

APPENDIX A

EMPLOYEE HEALTH AND SAFETY RULES

GENERAL SAFETY RULES

1. Immediately report unsafe acts, conditions, or equipment to your supervisor or Health and Safety representative.
2. Immediately report all accidents resulting in property damage, injury or illness to your supervisor.
3. "Horseplay" and "roughhousing" is not permitted on company property.
4. Each employee is responsible for issued safety equipment. Report loss or damage immediately.
5. Safety glasses/goggles and hard hats (where applicable) will be provided to all "visitors."
6. Smoking is prohibited except in designated areas.

ALCOHOL AND DRUGS

1. The possession, use, consumption, sale, purchase, or transfer of any illegal and unauthorized drugs, controlled substances, and alcoholic beverages is not permitted on Laidlaw properties or vehicles and is cause for immediate termination.
2. All employees must conform to Laidlaw's Substance Abuse Prevention Detection Program. (Labor contracts may preclude compliance with this program.)

COMPRESSED AIR

1. Never point an air hose at anyone.
2. Never use compressed air to clean clothing or equipment.
3. Never use compressed air to empty flammable liquid drums.
4. Do not remove pressure reducing devices.

ELECTRICAL

1. Only qualified personnel shall make electrical repairs or installations.
2. Consider all wires "live" until locked and tagged out. Keep a safe distance from "live" electricity.
3. Have electrical equipment properly grounded. Use only three-wire grounded receptacles and extension cords. Use Ground Fault Circuit Interrupter (GFCI) outlets or circuit breakers on all 110V outside, wet locations, or portable (5 KW or greater) power sources. Test GFCI before operation.
4. Do not use electrical power tools or equipment while standing in water. Keep cords out of wet areas.
5. Cord splices or repairs shall be electrically and mechanically equal to that cord's quality. No substandard patching is permitted.
6. Use explosion-proof fixtures and connections while working in confined spaces where flammable vapors could be present.
7. Inspect electrical grounding to prevent shock in case tool insulation breaks.
8. Inspect cord-supplied equipment for any ground problems before using .
9. Report suspect damaged equipment to your supervisor . Do not use until repaired and tested.

FALL PROTECTION

1. Use safety harness and safety line if rail protection or other fall protection is not available for heights of 4 feet or more.
2. Avoid shortcuts. Use ramps, stairs, walkways, or ladders.
3. Be sure of your footing. Watch out for overhanging or broken planks, slippery spots, loose objects, etc.
4. Do not block aisles or access to work areas. Maintain enough light on stairs, aisles, and work area to prevent falls.
5. Do not leave floor openings unprotected. Use strong cover, or 42-inch-high guardrail with midrail and toeboard.
6. Store cords, leads, hoses, etc. properly to avoid damage.
7. Spills and leaks are to be cleaned up immediately.

FIRE PROTECTION

1. Obey "NO SMOKING" signs.
2. Smoking is prohibited, except in designated areas.
3. Label clearly and store flammable liquid containers in a protected, ventilated, and approved area.
4. Use flammable liquids only in small amounts and in approved, self-closing containers.
5. Do not refuel a running vehicle or engine. Clean up spills before starting. Extreme caution must be taken when fueling vehicles or engines with hot surfaces.
6. Never use gasoline or any flammable liquid as a cleaner.
7. Store oily rags in approved self-closing metal containers and dispose of them properly.
8. Bond and ground all flammable liquid containers and transfer equipment when transferring or filling product.
9. Use only explosion proof electrical equipment in potentially flammable vapor areas.
10. Only approved fire extinguishers will be used. Do not obstruct fire extinguishers from direct view or access.
11. Keep salamanders and other portable heating equipment away from combustible materials.
12. Make sure engines are away from combustibles and exhaust is properly ventilated.

HAZARD COMMUNICATION

1. All employees have a right to know the properties of hazardous materials to which they may be exposed.
2. All employees will be informed of hazards of materials to which they are exposed through training and information provided by Laidlaw.
3. Material Safety Data Sheets (MSDS) are available on hazardous materials used at Laidlaw facilities.
4. All hazardous material containers obtained from outside suppliers shall identify the hazardous contents and appropriate hazard warning.

HEAD, FOOT, AND EYE PROTECTION

1. Hard hats and eye protection must be worn by employees and visitors in all areas where such requirements are indicated.
2. Wear safety glasses in designated areas or if the potential for an eye injury exists.
3. Splash goggles and/or face shields must be worn when there is a possibility of any injury from chemicals, dusts, chips, sparks or hot splashing metal.
4. Approved steel-toed, chemical resistant safety footwear must be worn in designated areas or where mechanical and/or chemical protection is necessary.

HEAT STRESS

1. Avoid prolonged exposure in hot environments by taking proper precautions. If you work in hot environments, make sure you do the following:
 - a. Drink plenty of liquids. Do not drink alcoholic beverages.
 - b. Take adequate rest periods in a cool, shaded environment.
 - c. Remove personal protective equipment during rest periods.

COLD STRESS

1. Avoid prolonged exposure in cold environments by taking proper precautions. If you work in cold environments, make sure you do the following:
 - a. Wear adequate clothing to protect against cold exposure.
 - b. Several thin layers of clothing with an outer wind barrier provides better protection as opposed to one thick layer.
 - c. Avoid use of damp or wet clothing.
 - d. Immediately remove any person from a cold environment who is suspected of suffering from hypothermia.
 - e. Do not rub any part of the body which may be frost bitten.

HOUSEKEEPING

1. Keep work site clean and orderly.
2. Shavings, dust, scraps, rags, oil or grease must not accumulate. Make good housekeeping part of the job. Remove tools and trash at the end of each job completion.
3. Keep loose materials off stairs, walkways, ramps, platforms, etc.
4. Do not block aisles, traffic lanes, fire exits or electrical panels and access to all emergency equipment such as eye washes, deluge showers, fire blankets, fire extinguishers, first aid supplies, emergency communication devices, etc.

LADDERS AND SCAFFOLDS

1. Inspect ladder before each use and do not use if damaged. Do not use painted wooden ladders.
2. When ascending or descending, the climber must face the ladder using both hands. Use hand line or material hoist to lift loads. Do not lift electrical tools by their cords.
3. Use only sturdy ladders on firm base. Angle base $1/4$ of ladder working length. Keep area clear of scrap, tools, hose, etc.
4. Have ladder reach at least three feet above landing for easy access. Tie off ladder at top. Secure bottom and brace long ladders.
5. Avoid using metal ladders in areas containing electric circuits to prevent short circuits or electric shock.
6. All scaffolds and their supports shall be capable of supporting the load they are designed to carry with a safety factor of at least 4.
7. All planking shall be of a scaffold grade, as recognized by grading rules for the species of wood used.
8. Platform planks should overlap supports not less than six inches nor more than 18 inches, and be secured from shifting.
9. Railings and toeboards shall be installed on all open sides and ends of platforms more than 4 feet above the floor.
10. Keep all tools and materials away from edge of scaffold, platforms, shaft openings, etc.

LIFTING

1. Always size up the load first. Get help with heavy or bulky materials to avoid dropping load or getting thrown off balance, or injuring your back. Refer to the Laidlaw Manual Material Handling procedure.
2. Bend knees, keep back nearly straight when lifting. Leg muscles, not your back, should do the work. Do not twist.
3. Have just one person give commands when team lifting oversized loads. Before lift, check for clear path. Then have clear view while carrying load.

MACHINES AND MACHINE GUARDING

1. Before starting machinery, opening valves, switches, etc., check safety of workmen. Have safety guards in place.
2. Never adjust or repair machinery while in motion. Lock out, block and/or bleed air as required to prevent any possible movement.
3. Operate machinery and vehicles within rated capacity and at safe speeds.
4. Report defective power tools or machinery to supervisor immediately.
5. Never alter or remove safety devices; such as guards, alarms, etc. from machinery.

NOISE

1. Prolonged exposure to excessive noise (above 85 decibels) without hearing protection can impair your hearing. Refer to the Laidlaw Hearing Conservation procedure for specific requirements.
2. Wear approved hearing protection in areas designated "Hearing Protection Required" (such as hydroblasting).

OVERHEAD LOADS

1. Be aware of work going on around you. Keep clear of suspended loads, traffic areas, etc.
2. Place barricades and signs to warn of overhead danger, traffic, excavation, etc. Have warning lights, flagman, or watchman if necessary.
3. Keep check on loads, lines, slings, blocks, clamps, or other tackle. Repair/replace defects. Hang up slings if not in use. Always check for sling capacity.

RESPIRATORY PROTECTION

1. Wear an approved respirator when working with hazardous materials or as directed by Health and Safety. Reference Laidlaw's Respiratory Protection procedure.

VEHICLES AND MOBILE EQUIPMENT

1. For all vehicles left unattended:
 - a. Shut off unattended fork lift, passenger and service vehicle engines
 - b. Place gears in park for automatic transmission; use first or reverse for manual transmission.
 - c. Set parking brake.

For vehicles in excess of 10,000 pounds gross vehicle weight (not parked on absolutely flat surfaces) also put chocks in place or turn wheels toward curb.

2. Do not ride or drive any vehicle or mobile equipment unless authorized. All occupants shall wear seat belts provided.
3. Keep unloaded forks in the down position when not loaded. Always travel with the load upgrade when ascending or descending grades in excess of 10 percent.
4. Perform vehicle pre-trip inspection and complete inspection report as required. Safety discrepancies must be corrected before using vehicle.
5. Use a spotter when backing vehicles whenever possible. Check the area for obstructions if a spotter is not available.
6. All power units must be equipped with a fire extinguisher that is properly filled and readily accessible.
7. Do not ride on the forks of lift trucks or on a load, rigging, hook or ball, or pickup bed.
8. Check operation of back up alarm. Do not alter or remove safety equipment such as alarms, fire extinguishers, etc. from vehicles.
9. Observe all federal, state, local and facility/project speed limits.


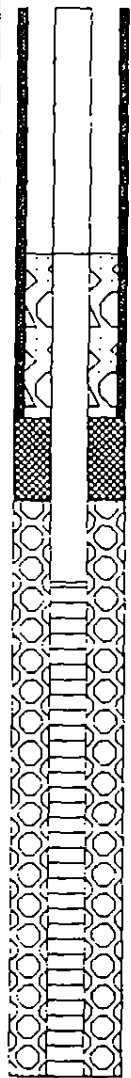

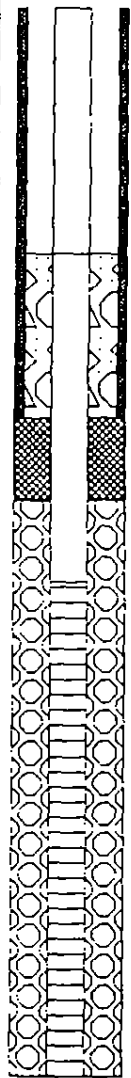
WELDING AND CUTTING

1. Welding, cutting and torching operations require a Hot Work Permit.
2. Welding and cutting work shall be closely supervised. Remove or shield nearby combustibles.
3. Keep a fire watch with adequate fire extinguishers during and after "hot work" as job location requires.
4. Do not look at welding or cutting operations without wearing proper eye protection.
5. Check hose, fittings, valves for leaks using soapy water. Cylinders shall be kept upright and secured.
6. Transport or move cylinders only with caps securely in place.
7. Keep oily cloths away from oxygen.
8. Always light torch with a "torch lighter", never use a match or cigarette. Never light in a keg or drum.
9. Open cylinder valves slowly to prevent damage to regulator. Never use a damaged regulator.
10. Do not wear oil-soaked or other contaminated clothing. Check clothing after work for hidden hot slag or molten metal.
11. Wear approved clothing and personal protective equipment for welding.
12. Bleed lines and shut off cylinders after each use.
13. Do not place torch unattended in manways of vessels or tanks.
14. Do not leave welding units on unattended.

JEWELRY, ORNAMENTS, LOOSE CLOTHING

1. Safe work practices shall be maintained and followed by employees, contractors and visitors while on Laidlaw property.
2. Jewelry or ornaments, i.e., rings, watches, bracelets, neck chains, and earrings shall not be worn while working with moving machines, power tools, and/or equipment where the possibility exists for entrapment of the jewelry or ornaments in the machines, power tools and/or equipment.
3. Long, loose hair or "pony tails" will be secured and covered at all process work locations and other work areas where the possibility exists for hair to become caught in machines, power tools and/or equipment or be contaminated with chemicals.
4. Loose clothing and attire; i.e., shirt tails, sleeves, neck ties, scarves, etc., shall be secured to prevent entrapment in moving machines, power tools and/or equipment.

APPENDIX 4-B
LYSIMETER BORING LOGS

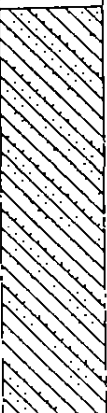
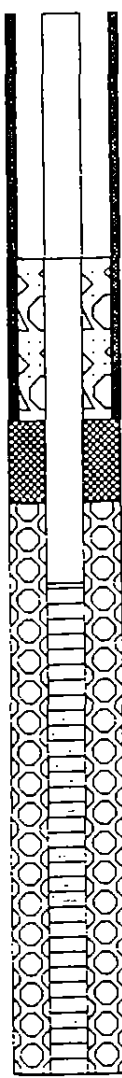

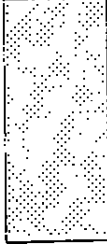
VIROGROUP BOREHOLE LOG								BOREHOLE NUMBER: L1		
PROJECT NUMBER: 07-02011.01 PROJECT NAME: PRELIMINARY GEOLOGIC INVESTIGATION LOCATION: COLFAX, LOUISIANA DRILLING COMPANY: LAYNE ENVIRONMENTAL RIG TYPE & NUMBER: B59 DRILLING METHOD: HOLLOW STEM WEATHER: CLOUDY, 30 FIELD PARTY: ALAN L. PIECHOCKI GEOLOGIST: ALAN L. PIECHOCKI DATE BEGUN: 12/22/93 DATE COMPLETED: 12/25/93								FIELD BOOK NO.: ALP-1 TOTAL DEPTH: -10.0 GROUND SURFACE ELEVATION: 169.8' SHEET: OF:		
								STATIC WATER LEVEL (BLS)		
								WD=White Drilling	AB=After Boring	
Depth (ft)										
Time										
Date:								12/22/93	12/23/93	
DEPTH	SOIL SAMPLES	SAMPLING RECOVER	SAMPLE NUMBER	MOISTURE	DENSITY	WATER LEVEL	QVA*100ppm	LOCATION DIAGRAM	LITHOLOGY	WELL INSTALLATION
3.0 2.0 1.0 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0				0				FILL, TOP SOIL AND SAND, with trace of silt; Dark red to brown; moderate density; very dry.		
				0				SILTY CLAY,, 5YR 5/2.		

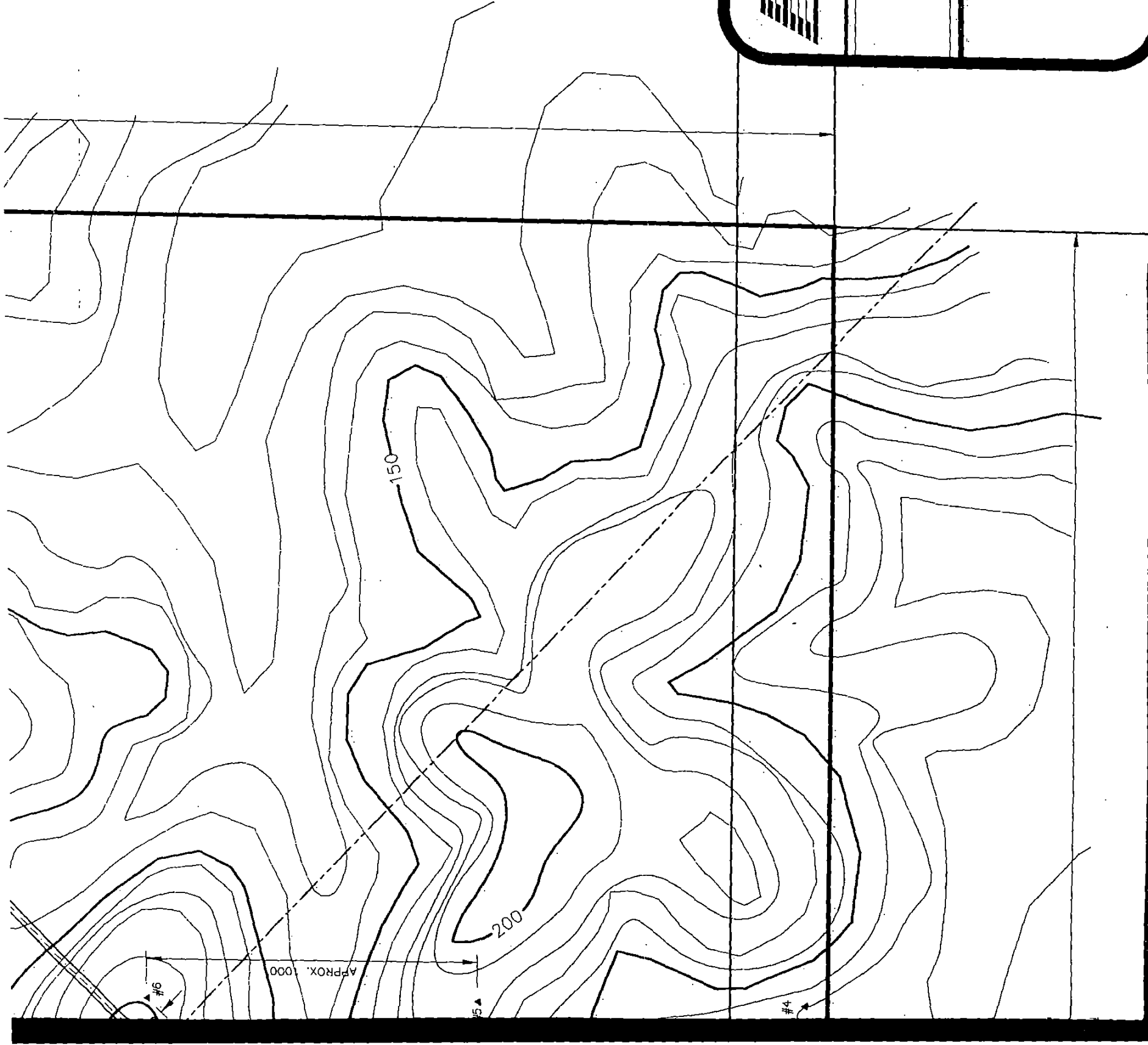
		VIROGROUP BOREHOLE LOG				BOREHOLE NUMBER L2				
PROJECT NUMBER: 07-02011.01 PROJECT NAME: PRELIMINARY GEOLOGIC INVESTIGATION LOCATION: COLFAX, LOUISIANA DRILLING COMPANY: LAYNE ENVIRONMENTAL RIG TYPE & NUMBER: B59 DRILLING METHOD: HOLLOW STEM WEATHER: CLOUDY, 30 FIELD PARTY: ALAN L. PIECHOCKI GEOLOGIST: ALAN L. PIECHOCKI DATE BEGUN: 12/22/93 DATE COMPLETED 12/26/93						FIELD BOOK NO.: ALP-1 TOTAL DEPTH: -10.0 GROUND SURFACE ELEVATION: 169.8' SHEET: OF:				
						STATIC WATER LEVEL (BLS)				
						WD=While Drilling AB=After Boring				
Depth (ft)										
Time										
Date:						12/22/93	12/23/93			
DEPTH	SOIL SAMPLES	SAMPLING RECOVER	SAMPLE NUMBER	MOISTURE	DENSITY	WATER LEVEL	CVA*100ppm	LOCATION DIAGRAM	LITHOLOGY	WELL INSTALLATION
30										
20										
10										
0.0				0				FILL SILT AND CLAY, with trace of silt, gray to brown; moderate density; very dry.		
10										
20										
30										
40								SANDSTONE, pale yellowish brown 10YR 6/2, very fine, with horizontal iron stains		
50				0						
60								SILTY CLAY, grayish olive green 5GY 3/2, very hard.		
70										
80										
90										
100				0						

VIROGROUP BOREHOLE LOG								BOREHOLE NUMBER: L3										
PROJECT NUMBER: 07-02011.01 PROJECT NAME: PRELIMINARY GEOLOGIC INVESTIGATION LOCATION: COLFAX, LOUISIANA DRILLING COMPANY: LAYNE ENVIRONMENTAL RIG TYPE & NUMBER: B59 DRILLING METHOD: HOLLOW STEM WEATHER: CLOUDY, 30 FIELD PARTY: ALAN L. PIECHOCKI GEOLOGIST: ALAN L. PIECHOCKI DATE BEGUN: 12/22/93 DATE COMPLETED: 12/26/93								FIELD BOOK NO.: ALP-1 TOTAL DEPTH: -10.0 GROUND SURFACE ELEVATION: 169.8' SHEET: OF:										
								STATIC WATER LEVEL (BLS)										
								WD=While Drilling	AB=After Boring									
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Depth (Ft)</td> <td style="width: 35%;"></td> <td style="width: 35%;"></td> </tr> <tr> <td>Time</td> <td></td> <td></td> </tr> <tr> <td>Date</td> <td></td> <td></td> </tr> </table>								Depth (Ft)			Time			Date				
Depth (Ft)																		
Time																		
Date																		
DEPTH	SOIL SAMPLES	SAMPLING RECOVER	SAMPLE NUMBER	MOISTURE	DENSITY	WATER LEVEL	OVA*100ppm	LOCATION DIAGRAM	LITHOLOGY	WELL INSTALLATION								
3.0 2.0 1.0 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0								<div style="border: 1px solid black; height: 100px; width: 100%; position: relative;"> <div style="position: absolute; top: 0; left: 0; right: 0; bottom: 0; border: 1px solid black;"></div> </div>										
								FILL SAND AND CLAY, with trace of silt; gray to brown; moderate density; very GR.										
								SILTY CLAY, GREYISH BROWN										
								SANDSTONE, pale yellowish brown 10YR 6/2, very fine, with horizontal iron stains										

VIROGROUP BOREHOLE LOG								BOREHOLE NUMBER: L4		
PROJECT NUMBER: 07-02011.01 PROJECT NAME: PRELIMINARY GEOLOGIC INVESTIGATION LOCATION: COLFAX, LOUISIANA DRILLING COMPANY: LAYNE ENVIRONMENTAL RIS TYPE & NUMBER: B59 DRILLING METHOD: HOLLOW STEM WEATHER: CLOUDY, 30 FIELD PARTY: ALAN L. PIECHOCKI GEOLOGIST: ALAN L. PIECHOCKI DATE BEGUN: 12/22/93 DATE COMPLETED: 12/26/93								FIELD BOOK NO.: ALP-1 TOTAL DEPTH: -10.0 GROUND SURFACE ELEVATION: 169.8' SHEET: OF		
								STATIC WATER LEVEL (BLS)		
								WD=While Drilling AB=After Boring		
Depth(ft)										
Time										
Date:										
DEPTH	SOIL SAMPLES	SAMPLING RECOVER	SAMPLE NUMBER	MOISTURE	DENSITY	WATER LEVEL	QVA*100ppm	LOCATION DIAGRAM	LITHOLOGY	WELL INSTALLATION
3.0 2.0 1.0 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0				0				<div style="border: 1px solid black; height: 100px; width: 100%;"></div>		
								FILL SAND AND CLAY, with trace of silt; gray to brown; moderate density, very dry		
				0				CLAY SILT SAND, very silty, pale yellowish brown 10YR 6/2, very fine.		
								SANDSTONE, pale yellowish brown 10YR 6/2, very fine, with horizontal iron stains		

VIROGROUP BOREHOLE LOG								BOREHOLE NUMBER: L5			
PROJECT NUMBER: 07-02011.01 PROJECT NAME: PRELIMINARY GEOLOGIC INVESTIGATION LOCATION: COLFAX, LOUISIANA DRILLING COMPANY: LAYNE ENVIRONMENTAL RIG TYPE & NUMBER: B59 DRILLING METHOD: HOLLOW STEM WEATHER: CLOUDY, 30 FIELD PARTY: ALAN L. PIECHOCKI GEOLOGIST: ALAN L. PIECHOCKI DATE BEGUN: 12/22/93 DATE COMPLETED: 12/26/93						FIELD BOOK NO.: ALP-1 TOTAL DEPTH: -10.0 GROUND SURFACE ELEVATION: 169.8' SHEET: OF:					
						STATIC WATER LEVEL (BLS)					
						WD=While Drilling AB=After Boring					
						Depth (ft)					
						Time					
						Date:	12/22/93		12/23/93		
DEPTH	SOIL SAMPLES	SAMPLING RECOVER	SAMPLE NUMBER	MOISTURE	DENSITY	WATER LEVEL	DVA*100ppm	LOCATION DIAGRAM		LITHOLOGY	WELL INSTALLATION
3.0 2.0 1.0 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0				0				FILL SAND AND CLAY, with trace of silt, gray to brown, moderate density			
								SILTY CLAY, SYR.			
				0				SANDSTONE, pale yellowish brown 10YR 6/2, very fine, with horizontal iron stains.			
				0							

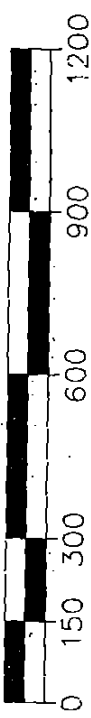
VIROGROUP BOREHOLE LOG								BOREHOLE NUMBER: L6		
PROJECT NUMBER: 07-02011.01 PROJECT NAME: PRELIMINARY GEOLOGIC INVESTIGATION LOCATION: COLFAX, LOUISIANA DRILLING COMPANY: LAYNE ENVIRONMENTAL RIG TYPE & NUMBER: B59 DRILLING METHOD: HOLLOW STEM WEATHER: CLOUDY, 30 FIELD PARTY: ALAN L. PIECHOCKI GEOLOGIST: ALAN L. PIECHOCKI DATE BEGUN: 12/22/93 DATE COMPLETED: 12/25/93								FIELD BOOK NO.: ALP-1 TOTAL DEPTH: -10.0 GROUND SURFACE ELEVATION: 169.8' SHEET: OF:		
								STATIC WATER LEVEL (BLS)		
								WD=While Drilling	AB=After Boring	
Depth(ft)										
Time										
Date:								12/22/93	12/23/93	
DEPTH	SOIL SAMPLES	SAMPLING RECOVER	SAMPLE NUMBER	MOISTURE	DENSITY	WATER LEVEL	OVA*100ppm	LOCATION DIAGRAM	LITHOLOGY	WELL INSTALLATION
3.0 2.0 1.0 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0				0				FILL SAND AND CLAY, gray to brown, moderate density; very dry		
				0				SILTY CLAY, 5YR 5/2.		
				0				SANDSTONE, pale yellowish brown 10YR 6/2, very fine, with horizontal iron stains		



LEGEND

- ▲ SOIL SAMPLING LOCATION

GRAPHIC SCALE

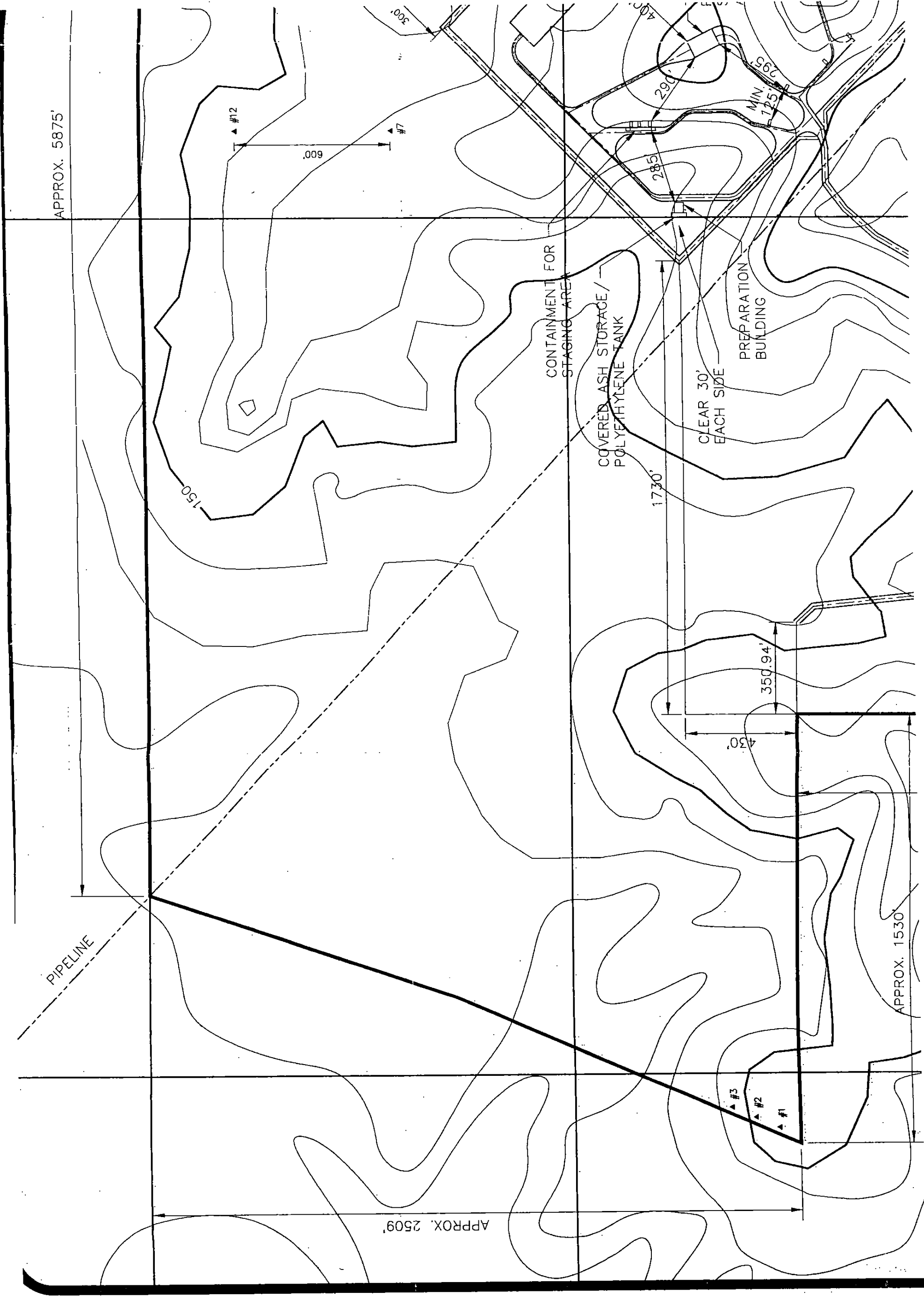


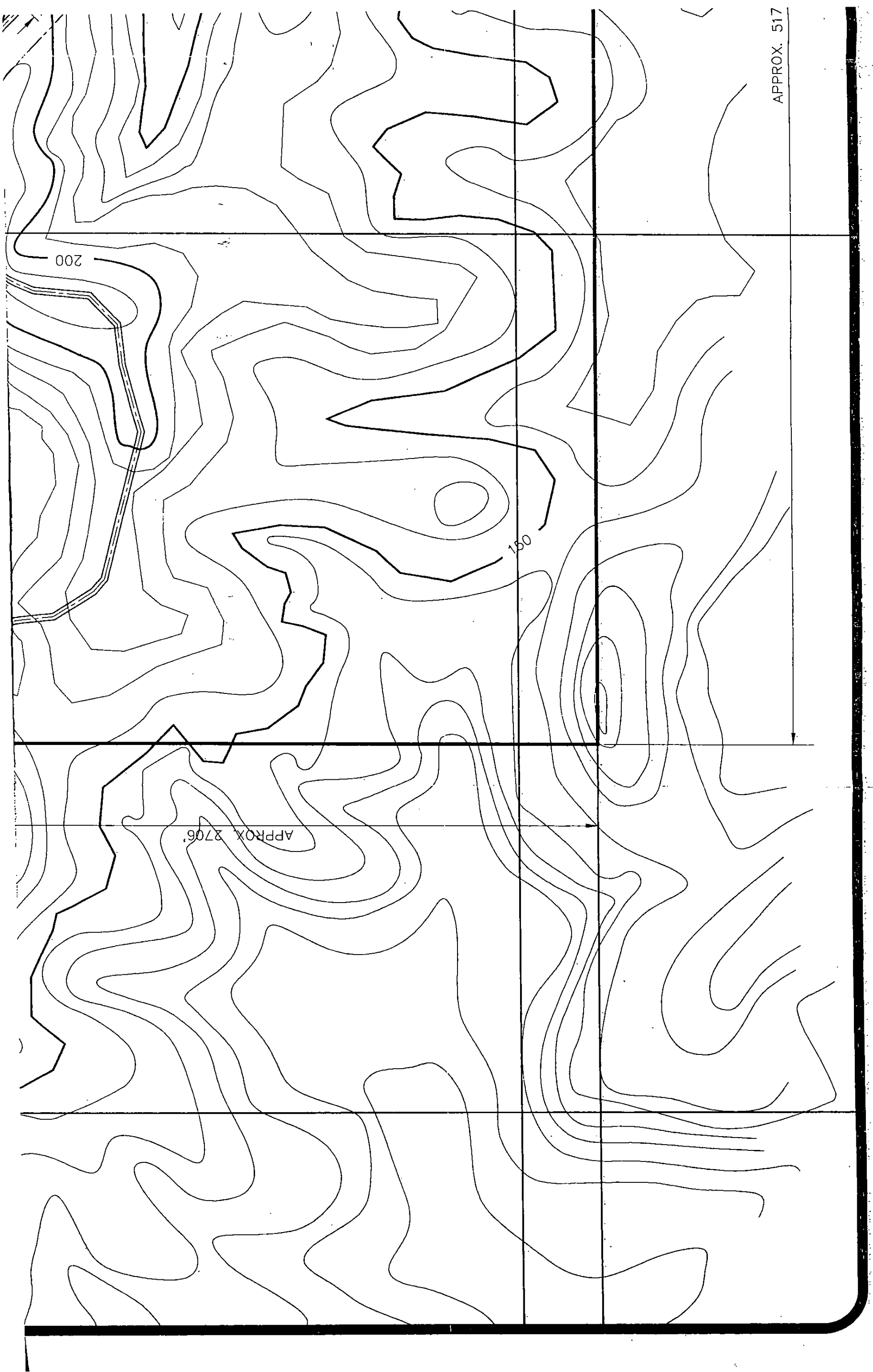
A Division of ViroGroup
P.O. Box 1867 • 1445 Plagah Church Rd. • Lexington, SC 29072
(803) 957-6270
Inc.

FIGURE 1
SOIL SAMPLING LOCATIONS

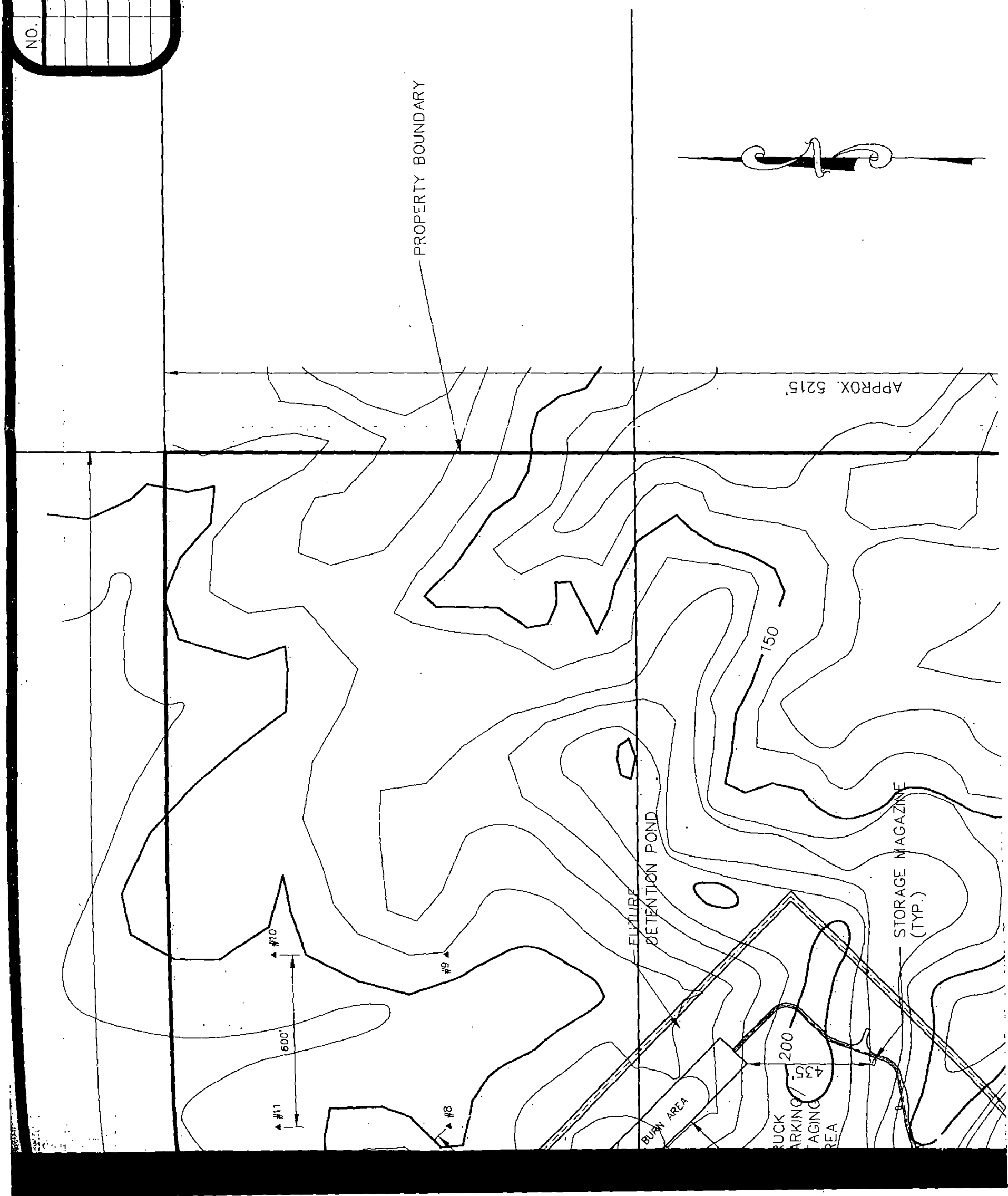
R&D FABRICATING &
MANUFACTURING, INC.

DRAWN BY:	CAB	DATE:	7/12/93
DESIGNED BY:	JDW	CADD NO:	G: 30913001
APPROVED BY:	<i>[Signature]</i>	PROJECT NO:	16-30913.00
SCALE:	1" = 300'	SHEET NO.	OF





NO.	REVISION	DATE	BY





ENVIRONMENTAL ASSESSMENT REPORT

**LAIDLAW ENVIRONMENTAL SERVICES
(THERMAL TREATMENT), INC.
COLFAX, LOUISIANA
EPA ID# LAD981055791**

**Volume II
January 1994**

**Environmental Resources Management, Inc.
Ewing, New Jersey**

Environmental
Resources
Management, Inc.

Princeton Crossroads
Corporate Center
300 Phillips Boulevard
Suite 200
Ewing, New Jersey 08618
(609) 895-0050
(609) 895-0111 (Fax)

16 February 1994
Reference: A9915.00.01

Mr. Rafael Casanova
USEPA
Hazardous Waste Management Division
RCRA Permits Branch (6H-P)
1445 Ross Avenue
Dallas, TX 75202-2733



Ms. Thelma Jenkins Anthony
Louisiana Department of Environmental Quality
Solid and Hazardous Waste Division
7290 Bluebonnet - H.B. Garlock Building, 5th Floor
Baton rouge, LA 70810

Re: Environmental Assessment Report Volume II - Screening Level
Human Health and Ecological Risk Assessment for Laidlaw
Thermal Treatment, Colfax, LA (EPA ID# LAD981055791)

Dear Mr. Casanova and Ms. Anthony:

Environmental Resources Management, Inc. (ERM) is submitting to each of you a copy of the above referenced Screening Level Risk Assessment. This report represents Volume II of the Environmental Assessment Report prepared by ERM and ViroGroup, Inc. on behalf of Laidlaw Thermal Treatment. This Screening Level Risk Assessment was carried out in accordance with a 15 June 1993 Workplan submitted by ViroGroup, Inc. to USEPA and which was approved by the agency in a 7 December 1993 letter to Laidlaw Thermal Treatment.

Please contact me at 609-895-0050 if you have any questions regarding this analysis and if I can assist you with reviewing the report. ERM appreciates your attention to this matter.

Sincerely,

Ronald Harkov, Ph.D.
Program Director

Casanova/Anthony
A9915.00.01
16 February 1994
Page 2

enclosures: Volume II

cc: L. Longshore
J. Gallion
R. Hall
K. Hallinger

SECTION V
AIR EMISSIONS
HUMAN HEALTH AND
ECOLOGICAL RISK ASSESSMENT

January 1994

Prepared By:

*Environmental Resources Management, Inc.
Princeton Crossroads Corporate Center
300 Phillips Boulevard, Suite 200
Ewing, New Jersey 08618*

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On 25 September 1992, Laidlaw Environmental Services Thermal Treatment, Inc. (LES Thermal Treatment) of Colfax, Louisiana submitted a Resource Conservation and Recovery Act (RCRA) Part B Permit Application for the operation of a Subpart X facility (miscellaneous units). The U.S. Environmental Protection Agency (EPA) issued a RCRA Subpart X Hazardous Waste Permit to the company on 31 March 1993 for the operation of thermal treatment units and a waste preparation building. The treatment permit was issued subsequent to the issuance of a storage permit by the Louisiana Department of Environmental Quality (DEQ) regulating on-site storage of reactive waste. The full RCRA permit was developed under a joint permitting agreement between the EPA and the DEQ.

Section 264.601 of Subpart X requires a facility to demonstrate compliance with environmental performance standards to ensure protection of human health and the environment. The environmental assessment process is designed to demonstrate compliance with these standards for affected media of exposure. As part of the environmental assessment, air quality modeling was undertaken to estimate ambient air quality concentrations of particulate matter and total dry deposition of particulate matter to the soil. Concentration and deposition data were utilized by risk assessors in completing human health and ecological risk evaluations. The evaluations were performed in accordance with the Virogroup, Inc.'s June 1993 "Environmental Assessment Work Plan for R & D Fabricating and Manufacturing, Inc." as conditionally-approved by USEPA in their 7 December 1993 Work Plan Approval Letter. Appropriate USEPA risk assessment guidance documents were utilized throughout the evaluation; however, whenever possible, site-specific information/data were incorporated into the assessment.

This report provides background information and describes the methodologies and results of the risk screening evaluation for the facility. A description of the facility including surrounding land use and incineration operations is provided in this section. Emissions estimates and air dispersion modeling methodologies and results are discussed in Section 2.0, and the human health risk assessment and ecological risk assessment methodologies and results are presented in Sections 3.0 and 4.0 of this report, respectively.

The LES Thermal Treatment facility is located approximately 0.5 miles north of Highway 71 on Highway 471 in Grant Parish, Louisiana near Colfax. Route 471 bounds the property to the west and an underground pipeline traverses the property from the northwest corner to the southeast corner. Only a few dirt roads occur on the property. The total size of the property is approximately 700 acres, of which approximately 43 acres in the central portion of the property is used for facility operations. The location of the property and the facility boundary are presented in Figure 1-1.

Twenty thermal treatment units are placed on a concrete pad at the center of the site with a preparation building located within 600 feet of the pad. The pad and building are contained within a perimeter fence to restrict unauthorized access. Entrance and exit from this secure area are controlled by a guard situated at the only access point. Figure 1-2 presents the most recent site layout map indicating the approximate location of each of the twenty thermal treatment units.

The twenty thermal treatment units are all of the same design. Each consists of a four-foot high and four-foot diameter concrete pipe set on end. Reactive waste materials are soaked in diesel fuel for approximately 30 minutes prior to burning. Each batch of waste requires approximately 7 to 8 minutes to burn. Burning occurs only during daylight hours.

Topographic map of the Colfax, Louisiana area. The map shows contour lines, a grid, and various geographical features. Key labels include 'Branch', 'Summerfield', 'Bayou', 'Grappe', and 'The Rock'. A legend indicates 'Property Boundary' and a scale bar shows distances up to 2000 feet. A north arrow is present in the bottom left corner.

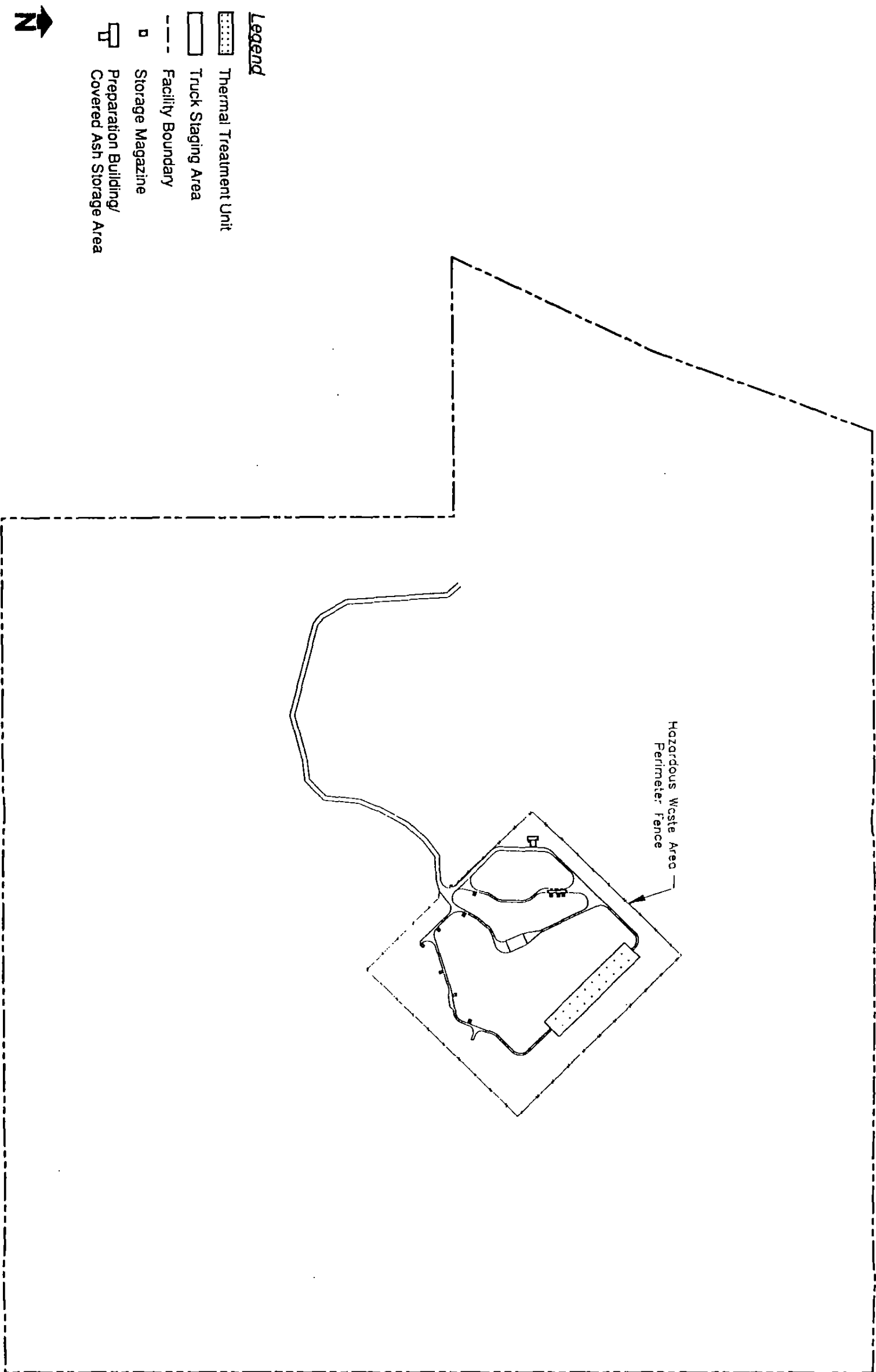
Thermal Treatment Units

Property Boundary

scale in feet

Source: USGS Topographic Quadrangle, Colfax, Louisiana

Figure 1-2
Site Layout Map
R & D Fabricating and Manufacturing
Subpart X Facility
Colfax, Louisiana



MAXIMUM MASS EMISSIONS ESTIMATES AND AIR DISPERSION MODELING

Maximum mass emission estimates were derived from previous work completed by ENSR Consulting and Engineering (1991). These results were then used in combination with air dispersion modeling results to estimate human and ecological exposure.

MAXIMUM MASS EMISSIONS ESTIMATES

The ENSR April 1991 report included the emission testing results from two (2) runs of lead azide ($\text{Pb}(\text{N}_3)_2$, MW = 291.2 #/#-mole). These emission testing results were used to estimate the worst-case metals mass emission rates for the purposes of the present screening assessment. The following discussion describes the derivation of the worst-case metal mass emission rates.

- Determination of Mass Throughputs of Lead Azide

Both runs had six (6) burners in operation over a one (1) hour period and each burner contained 0.18 pounds of lead azide:

$$\begin{aligned} 6 \text{ burners/hr} \times 0.18 \text{ \# Pb(N}_3)_2/\text{burner} &= 1.08 \text{ \# Pb(N}_3)_2/\text{hr} \\ (207.2 \text{ \# / \#-mole for Pb}) / (291.2 \text{ \# / \#-mole for Pb(N}_3)_2) \times 1.08 \\ \text{\#Pb(N}_3)_2/\text{hr} &= 0.769 \text{ \# Pb/hr} \end{aligned}$$

Thus, the Pb throughputs were 0.769 #/hr.

- Estimation of Mass Emission Rates for Run #1

The ENSR emission rate measurement indicated that Pb emissions were 0.0265 g/s:

$$\begin{aligned} (0.0265 \text{ g Pb/s}) \times (60\text{s/min}) \times (60\text{min/hr}) \times (1/454 \text{ g/\#}) \\ = 0.21 \text{ \# Pb/hr} \end{aligned}$$

Thus, the mass emission rate during Run #1 was

$$(0.21 \text{ \# Pb/hr}) / (0.769 \text{ \# Pb/hr}) = 27.3\% \text{ of the Pb.}$$

- Estimation of Mass Emission Rates for Run #2

The ENSR emission rate measurement indicated that Pb emissions were 0.017 g/s:

$$(0.017 \text{ g Pb/s}) \times (60\text{s/min}) \times (60\text{min/hr}) \times (1/454 \text{ g/\#}) = 0.134 \text{ \# Pb/hr}$$

Thus, the mass emission rate during Run #2 was

$$(0.134 \text{ \# Pb/hr}) / (0.769 \text{ \# Pb/hr}) = 17.5\% \text{ of the Pb.}$$

- Estimation of Average Mass Emission Rates

The mass emission rate measurements were 27.3% and 17.5% or the average emission rate was 22.4% Pb.

To develop acceptable emission rates, ERM conservatively assumed that all metals except Hg, had a mass emission rate of 30 percent. Mercury was assumed to have a 100 percent mass emission rate. Assigning all metals (except Hg) that will be evaluated in this screening assessment the same mass emission rate is an inherently conservative assumption since Pb is a relatively volatile metal. For example, the information in the following table was presented by Dempsey and Oppelt (1993), "Incineration of Hazardous Waste: A Critical Review Update, JAMWA 43: 25", and indicates that of all the metals (Al was not included in this document) addressed in this screening assessment only Se and Hg are more volatile than Pb.

<u>Metal</u>	<u>Volatility Temperature, (°C)</u>
Cr	1613
Ni	1210
Be	1054
Ba	849
Sb	660
Pb	627
Se	318
Hg	14

ERM contacted Department of Defense researchers and completed an exhaustive computerized literature search of technical and government publications, but we could not identify emission rate information that would be useful for the present screening risk assessment effort. Thus we used conservative mass throughput information with regard to metals in waste streams to be handled at the LES Thermal Treatment facility to assist in defining worst-case metal emission rates.

LES Thermal Treatment provided maximum metal throughputs for the Colfax, LA facility based on the fact that the specific wastes each would represent 50 percent of the total wastes handled by the facility in any one year. ERM derived acceptable, worst-case emission rates (ERs) based on this information. Table 2-1-1 presents emissions estimates and throughput calculations.

Note that the thermal treatment facility is permitted to thermally treat 164 #/hr of explosives and operate 2,920 hr/yr. Thus the maximum annual throughputs for explosives is approximately 239 tons per year (TPY).

Table 2-1-1. Emissions and Throughputs Calculations

Metal	Emissions	Throughputs (100% emissions)	Throughputs (30% emissions)
	g/sec	tons/year	tons/year
Al	6.48E+00	7.50E+01	250
Ba	5.18E-01	6.00E+00	20
Be	8.64E-04	1.00E-02	0.033
Cr	6.05E-04	7.00E-03	0.023
Cu	8.64E-02	1.00E+00	3.333
Hg	2.50E-01	2.90E+00	2.9
Ni	9.50E-02	1.10E+00	3.667
Pb	8.03E-01	9.30E+00	31
Sb	8.64E-02	1.00E+00	3.333
Se	2.59E+00	3.00E+01	100
Zn	8.64E-02	1.00E+00	3.333

With a 100 percent mass emission rate, the throughputs included above equal approximately 127 TPY or represent nearly 53 percent of the total annual facility-wide throughputs of explosives. Using the conservative 30 percent mass emission rate derived from actual source testing at the LES Thermal Treatment facility, the throughputs included above equal approximately 418 TPY or represent nearly 175 percent of the total annual facility-wide throughputs of explosives.

Most of the explosives to be thermally treated at the LES Thermal Treatment facility are composed of organic materials such as RDX and TNT. Metals represent a small fraction of the total quantity of wastes to be handled by LES Thermal Treatment. For example, the facility personnel estimate that the realistic maximum anticipated metal throughputs are less than 20 TPY. Thus the facility was modeled using metal emission rates which are conservatively over six (6) times the maximum anticipated metal throughputs in any single year.

2.2

AIR DISPERSION MODELING

The Industrial Source Complex Short Term Version 2 (ISCST2) model, implemented by Bowman Environmental Engineering, was used to estimate the impacts based on unit emissions from the thermal treatment units. Actual pollutant concentrations and deposition rates are directly proportional to emission rate; therefore, unit emission model values for these parameters must be multiplied by the actual emission rate from each thermal treatment unit in order to estimate the actual parameter values.

For modeling purposes, each thermal treatment unit was assumed to be a volume source. The source inputs for a volume source are emission rate, location (x,y coordinates), release height, initial vertical dimension, and initial horizontal dimension. The emission rate was assumed to be 1 gram per second (g/sec). The initial vertical dimension and the initial horizontal dimension were determined from a previous study which included visual observations of an actual trial burn. The height of the release was assumed to be at the level of the observed plume centerline, 6 meters. The initial vertical dimension was estimated at 2.8 meters, which is the observed plume centerline of 20 feet (6 meters) divided by the factor (2.15) recommended by ISC model documentation for volume sources. Similarly, the initial horizontal dimension was estimated at 1.4 meters (plume diameter of 10 feet or 3 meters divided by 2.15). Locations of the twenty thermal treatment units, as modeled, are summarized in Table 2-2-1.

Table 2-2-1 Locations of the Thermal Treatment Units

Unit Number	X-Coordinate (meters)	Y-Coordinate (meters)
1	730	803
2	742	816
3	754	830
4	766	842
5	878	855
6	889	868
7	900	881
8	912	895
9	924	909
10	935	922
11	826	721
12	838	733
13	859	747
14	860	761
15	871	774
16	883	788
17	895	801
18	907	815
19	919	828
20	930	841

The ISCST2 model source input included emission factors to adjust unit emission rates to reflect burning only during daylight hours. Daylight was assumed to be during the hours of 0600 local time and 2000 local time throughout the year. Emission factors for these hours were set at 1.0. Emission factors for the remaining hours of darkness were set at 0.0.

The ISCST2 model was used to estimate the concentration of particulates in the air and to estimate the deposition rate of particulates. All deposition was assumed to be in the form of dry deposition because the facility will not operate during precipitation.

In order to model the influence of particle deposition on concentration and deposition rate, it was necessary to assume a particle size distribution for emissions from the thermal treatment units. Since no site-specific data were available for this modeling study, the particle size distribution for combustion of mixed fuels, published in AP-42 (Appendix C.2, page C.2-9), was used. The particle size distribution is representative since the waste material at the thermal treatment facility is soaked in diesel fuel prior to combustion. Particle data are presented in Table 2-2-2. For each particle size, a settling velocity (V_s) was calculated from an equation recommended in the ISC User's Guide (U.S. EPA, 1987) as follows:

$$V_s = 2 p g r^2 / 9 \mu$$

where:

V_s	=	settling velocity
p	=	particle density
g	=	acceleration due to gravity
r	=	particle radius
μ	=	absolute viscosity of air

Settling velocities are included in Table 2-2-2. Finally, the ISC model requires an input of the reflection coefficient to allow for the resuspension of particulate matter which impacts the ground. For this analysis, a reflection coefficient of zero was assumed for all particle sizes. This assumption results in the maximum possible deposition and therefore results in a conservative estimate of deposition rates.

Table 2-2-2 Particle-size Distribution and Settling Velocities

Particle Size Range (μm)	Mass Fraction	Settling Velocity (cm/sec)
<1.0	0.23	0.00074
1.0 - 2.0	0.17	0.00669
2.0 - 2.5	0.05	0.01506
2.5 - 3.0	0.05	0.02250
3.0 - 4.0	0.08	0.03645
4.0 - 5.0	0.06	0.06025
5.0 - 6.0	0.06	0.09000
6.0 - 10.0	0.09	0.19040
>10.0	0.21	0.29750

2.2 METEOROLOGICAL DATA AND RECEPTORS

2.2.1 Meteorological Data

The ISCST2 modeling was completed using actual hourly meteorological data from representative surface and upper air stations. The surface data were taken from England Air Force Base, which is located near Alexandria, Louisiana and near the facility. The upper air data were taken from Longview, Texas. Data from 1987 through 1991 were used. An analysis of the land use surrounding the site indicated that the surrounding land use was primarily rural. Consequently, the ISCST2 model was run using the regulatory default options assuming rural land use.

2.2.2 Receptors

The receptor network was established to permit calculation of particulate concentrations and deposition rates within the facility's property, at the fenceline, and outside the fenceline. The network consisted of receptors placed on a grid with x-coordinates ranging from 5,000 m to -4,000 m as follows: 5,000 m, 4,000 m, 3,000 m, 2,500 m, 2,000 m, 1,800 m, 1,600 m, 1,400 m, 1,200 m, 1,000 m, 800 m, 600 m, 400 m, 200 m, -12 m, -200 m, -400 m, -600 m, -1,000 m, -1,500 m, -2,000 m, -2,500 m, -3,000 m, and -4,000 m. The y-coordinates for the grid ranged from 5,000 m to -5,000 m as follows: 5,000 m, 4,000 m, 3,000 m, 2,800 m, 2,600 m, 2,400 m, 2,200 m,

2,000 m, 1,800 m, 1,578 m, 1,400 m, 1,300 m, 1,200 m, 1,100 m, 1,000 m, 900 m, 812 m, 600 m, 400 m, 200 m, -12 m, -200 m, -400 m, -600 m, -800 m, -1,000 m, -1,500 m, -2,000 m, -2,500 m, -3,000 m, -4,000 m, and -5,000 m. The northern boundary of the property was along $y=1,578$ m between $x=-12$ m and $x=1,568$ m. The eastern boundary was along $x=1,568$ m between $y=-12$ m and $y=1,578$ m. The southern boundary was along $y=-12$ m between $x=-12$ m and $x=1,568$ m. The western boundary extended from $x=-12$ m and $y=-12$ m (-12,-12) to (-12,812) to (-475,812) to (-12,1578). The twenty thermal treatment units were modeled at locations indicated on Table 2-1 in the vicinity of $x=800$ m and $y=800$ m. Terrain in the area is relatively unimpressive. Since the modeling is being conducted at a screening level, small scale variations in terrain were not considered important. Therefore, receptor elevations, based on the surrounding terrain, were not input to the model.

2.3

MODELING APPROACH

The ISCST2 model was run to estimate the one-hour and annual average concentrations in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and annual deposition rates in grams per square meter per year ($\text{g}/\text{m}^2/\text{yr}$) of particulates. Unit emission rates were assumed for each of the twenty thermal treatment units. Other model inputs were described in Sections 2.1 and 2.2.

Outputs of one-hour and annual average concentrations and one-hour and annual deposition rates for each receptor point were generated for each of the years 1987-1991. Maxima for receptors along the property line and within the limits of the facility property line were identified. Maximum deposition and concentration values averaged over a five year period were assumed to represent reasonable worst-case conditions, and iso-deposition and iso-concentration maps of the annual deposition and annual average concentration were produced to show the distribution of these parameters over the site.

MODELING RESULTS

The ISCST2-estimated annual average concentrations on-site and along the fenceline are provided in Table 2-2-3. The table indicates the maximum value with the year of occurrence and the maximum five-year average annual concentration with its coordinate location. Model output for the estimation of average concentration at receptor for the years 1987-1991 are provided in Appendix 1. Similar data are provided for annual deposition rates in Table 2-2-4 and model output for deposition is also provided in Appendix 1.

Figure 2-1 is an iso-concentration map of the mean annual concentration of particulates over the site, derived from the worst case concentration value averaged over 5 years. Figure 2-2 is an iso-deposition map of the annual deposition over the site, derived from the worst case deposition value averaged over 5 years.

Table 2-2-3 ISCST2-estimated Maximum Annual Average Concentrations *

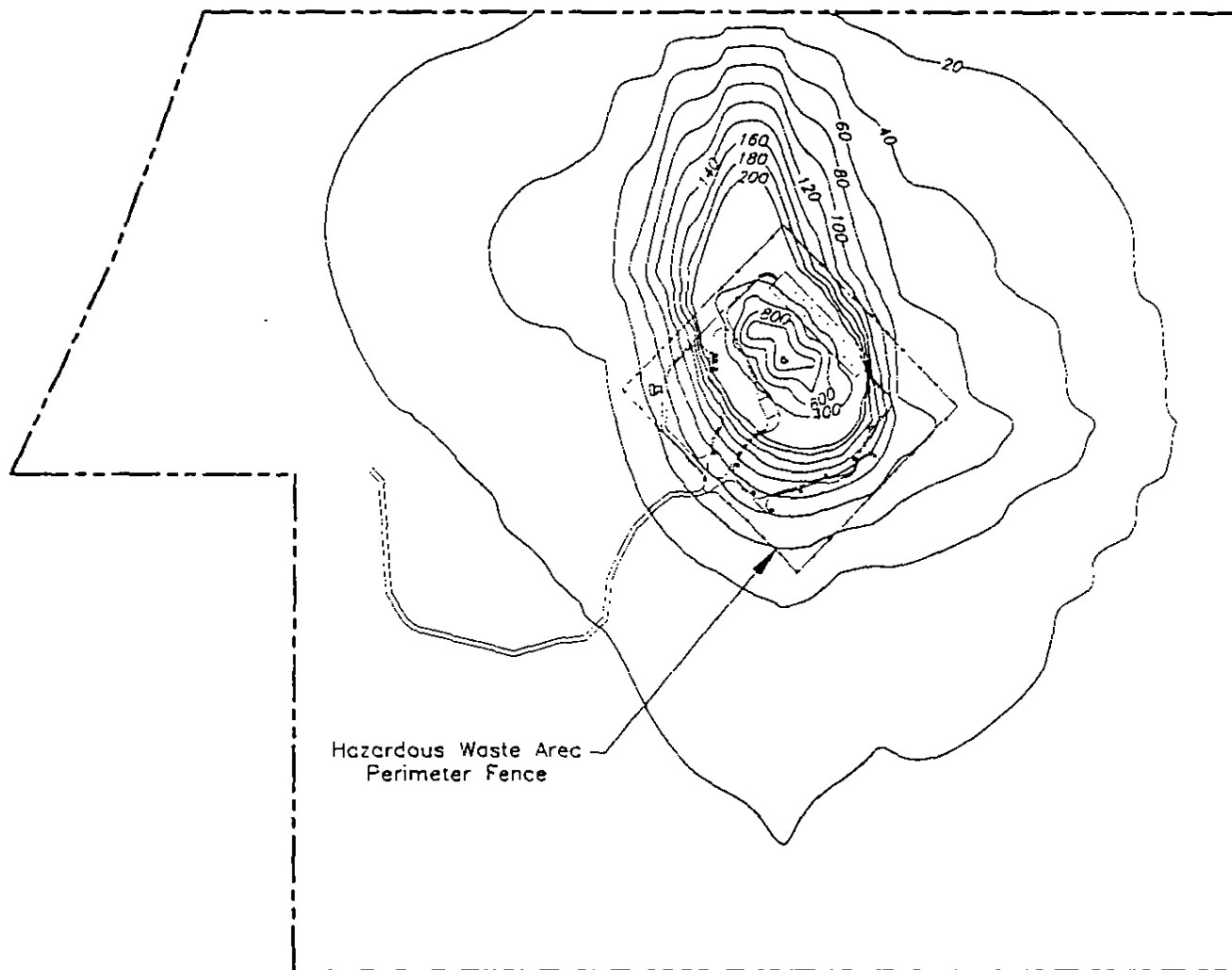
Location	Maximum One-year ($\mu\text{g}/\text{m}^3$)	Year	Five-year Average ($\mu\text{g}/\text{m}^3$)	Coordinate Location (x,y meters)
On-site Maximum	1333	1991	1244	800,-12
Southern Boundary	12.1	1991	9.5	800,-12
Eastern Boundary	10.5	1987	7.4	1568,500
Northern Boundary	29.8	1990	25.7	500,1578
Western Boundary	8.4	1991	6.3	-12,600

Table 2-2-4 ISCST2-estimated Maximum Annual Average Deposition Rates *

Location	Maximum One-year ($\text{g}/\text{m}^2/\text{yr}$)	Year	Five-year Average ($\text{g}/\text{m}^2/\text{yr}$)	Coordinate Location (x,y meters)
On-site Maximum	21746	1991	20506	800,1000
Southern Boundary	3.6	1989	3.5	800,-12
Eastern Boundary	3.9	1987	2.7	1568,600
Northern Boundary	17.1	1990	12.5	800,1578
Western Boundary	2.8	1991	2	-12,600

* Note: $Q=1$ g/sec from each of the 20 burner units or 20 g/sec for the entire thermal treatment facility

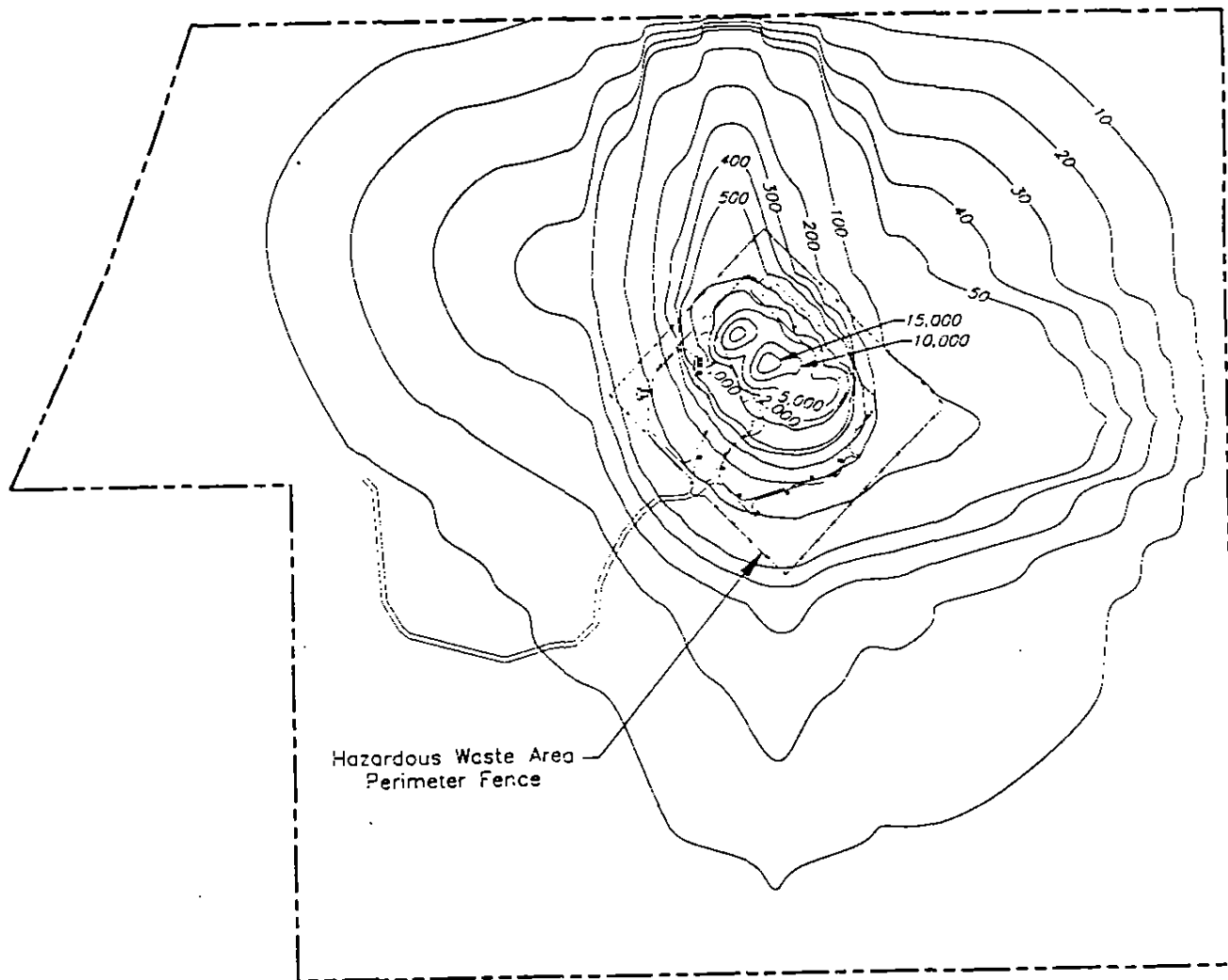
Figure 2-1
5-Year Average Iso-concentration Map
R & D Fabricating and Manufacturing
Subpart X Facility
Colfax, Louisiana



300 150 0 300
Scale in Meters



Figure 2-2
5-Year Average Iso-deposition Map
R & D Fabricating and Manufacturing
Subpart X Facility
Colfax, Louisiana



300 150 0 300
Scale in Meters



The human health risk assessment screening analysis consisted of several steps, namely hazard identification, toxicological assessment, exposure assessment, risk characterization, and an uncertainty analysis. The following sections describe the methods and results of each step in the human health risk assessment process.

3.1**HAZARD IDENTIFICATION**

Hazard identification involves the selection of constituents of concern based on the quantity and nature of chemicals released from the LES Thermal Treatment facility. Based on the nature of the wastestreams to be incinerated at the facility, USEPA required, in their 7 December 1993 response letter, that the following chemicals be included in the risk assessment:

- Aluminum (Al),
- Antimony (Sb),
- Arsenic (As),
- Barium (Ba),
- Beryllium (Be),
- Cadmium (Cd),
- Chromium (Cr),
- Copper (Cu),
- Lead (Pb),
- Mercury (Hg),
- Nickel (Ni),
- Selenium (Se), and
- Zinc (Zn).

It should be noted that total chromium was evaluated as hexavalent chromium. This assumption was conservative in nature because hexavalent chromium will likely represent only a small contribution to total chromium content of the material proposed for incineration. Arsenic and cadmium were not evaluated due to LES Thermal Treatment

reviewing wastestream chemistry and determining that the two metals are largely absent in the materials proposed for incineration.

3.2 TOXICOLOGICAL ASSESSMENT

3.2.1 TOXICITY PROFILES FOR TARGET METALS

All toxicological values for the specific metals were obtained through IRIS (Integrated Risk Information System, December, 1993). Additional information regarding toxicological studies was found in HEAST (Health Effects Assessment Summary Tables, March, 1993). Tables 3-2-1 and 3-2-2 present the toxicological values used in the exposure assessment, and toxicity profiles for the target metals are provided in Appendix 2.

3.3 EXPOSURE ASSESSMENT

The exposure analysis includes development of plausible exposure scenarios for the media of concern and derivation of intake equations to calculate the magnitude of dose. This quantitation of potential exposures provides a numerical basis for the characterization of risk.

For the purposes of the human health screening assessment, ERM used conservative exposure scenarios in order to predict "reasonable worst-case" exposures to the target chemicals. Potential direct exposure pathways include inhalation of airborne particulates, inadvertent ingestion of soil containing settled particulates, and dermal contact with potentially contaminated soil. The pathways selected for this assessment are based on site-specific land use and demographic information which indicates limited agricultural and residential use in proximity to the site. Based on this information, only the inhalation and soil ingestion pathways were evaluated in the human health risk assessment because they represent the only plausible exposure pathways potentially impacting off-site populations; these evaluations were consistent with the Virogroup, Inc.'s June 1993 "Environmental Assessment Work Plan for R & D Fabricating and Manufacturing, Inc." as conditionally-approved by USEPA in their 7 December 1993 Work Plan Approval Letter.

3.3.1 *Summary of Modeling Used for Human Exposure*

The human exposure assessment relies heavily on the use of models to evaluate human exposure to chemicals emitted. In designing this assessment, models were selected that have been developed, reviewed, and/or recommended by the EPA.

Table 3-2-1. Carcinogenic Toxicological Indices for Compounds of Interest

Compounds	Carcinogen Class (EPA)	Carcinogenic Slope Factor (CSF)		CSF Source
		Oral (kg-day/mg)	Inhalation (kg-day/mg)	
Aluminum (Al)		NA	NA	
Arsenic (As)	A	1.75	15	IRIS
Barium (Ba)		ND	ND	IRIS
Beryllium (Be)	B2	4.3	8.4	IRIS, HEAST
Cadmium (Cd)	B1	NA	6.1	IRIS
Chromium VI (Cr)	A	ND	41	IRIS
Copper (Cu)	D	NA	NA	IRIS
Mercury (Hg)	D	NA	NA	IRIS
Nickel (Ni), refinery dust	A	ND	0.84	IRIS
Lead (Pb)	B2	ND	ND	IRIS
Antimony (Sb)		ND	ND	IRIS
Selenium (Se)	D	NA	NA	IRIS
Zinc (Zn)	D	NA	NA	IRIS

ND:No data are available for the development of a slope factor.

NA:Not applicable

IRIS:EPA's On-Line Integrated Risk Information System accessed 12/93.

CSF:Carcinogenic Slope (Potency) Factor

HEAST:Health Effects Assessment Summary Table, EPA 540-R-93-058, 3/93.

Table 3-2-2. Non-Carcinogenic Toxicological Indices for Compounds of Interest

Compounds	RfD (mg/kg/day)		Source
	Oral	Inhalation	
Aluminum (Al)	NA	NA	IRIS
Arsenic (As)	3.00E-04	ND	IRIS
Barium (Ba)	7.00E-02	5.00E-04	IRIS, HEAST
Beryllium (Be)	5.00E-03	ND	IRIS
Cadmium (Cd)	1.00E-03 (food) 5.00E-04 (water)	pending	IRIS
Chromium VI (Cr)	5.00E-03	pending	IRIS
Copper (Cu)¶	3.71E-02	ND	ERM, HEAST
Mercury (Hg)	3.00E-04	8.57E-05	HEAST
Nickel (Ni), soluble salts	2.00E-02	ND	IRIS, HEAST
Lead (Pb)Δ	ND	4.29E-04	ERM
Antimony (Sb)	4.00E-04	ND	IRIS
Selenium (Se)	5.00E-03	ND	IRIS
Zinc (Zn)	3.00E-01	ND	IRIS

ND: No data are available for the development of a slope factor.

NA: Not applicable

IRIS: EPA's On-Line Integrated Risk Information System accessed 12/93.

CSF: Carcinogenic Slope (Potency) Factor

HEAST: Health Effects Assessment Summary Table, EPA 540-R-93-058, 3/93.

Δ No toxicity data exist for lead. An inhalation RfD was estimated based on the National Ambient Air Quality Standard (1.5 µg/m³, quarterly average) for lead using the following equation:

$$\text{estimated inhalation RfD} = \frac{1.5 (\mu\text{g}/\text{m}^3) * 1 (\text{mg}) * 20 (\text{m}^3)}{70 (\text{kg}) * 1000 (\mu\text{g}) * 1 (\text{day})}$$

[estimation assumes a 70 kg person inhaling 20 m³ air/day]

¶ No toxicity data exist for this chemical. An oral RfD was estimated based on Federal Maximum Contaminant Levels using the following equation:

$$\text{estimated oral RfD} = \frac{\text{MCL (mg/L)} * 2 \text{ L}}{70 (\text{kg}) * 1 (\text{day})}$$

[estimation assumes a 70 kg person drinking 2 L/day]

As discussed in Section 2.0, the ISCST2 model was used to model atmospheric concentrations and deposition rates from the source area. The concentrations and deposition rates are based on unit emission rates for each of the twenty thermal treatment units. The concentrations and deposition rates at the fence line were then used to estimate exposure to an MEI (maximally exposed individual).

The fence line concentrations and deposition rates were input to a modified version of a food chain model developed at Oak Ridge National Laboratory (Travis et al., 1988). Modifications were made in the Travis model to ensure consistency with the EPA Food Chain Model outlined in the Interim Final Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions (EPA, 1990). Further modifications have been made to account for changes made in USEPA's Addendum to the Methodology of 1990, as issued in 1993.

The food chain model estimates human daily intake of pollutants through the following food chain pathways: soil-human, plant-human, soil-animal-human, plant-animal-human, water-fish-human. ERM adapted the model to account for human exposure via the inhalation pathway in addition to the food chain pathways; this adaptation enabled the ISCST2 data to be input once to one model. While the capabilities of the food chain model exceeded the needs of the present screening assessment, the model provided an efficient methodology to estimate human and ecological exposure.

For this human exposure assessment, only soil ingestion and inhalation pathways were considered. The model used the unitized deposition rates and concentrations and the emission rates (see Section 2.1 for the derivation of the emission rates) to calculate annual deposition rates and air-borne concentrations. Soil concentrations could then be calculated using the following parameters: deposition rate, facility lifetime, pollutant loss rates from the soil, and the depth of contamination (1 cm for direct soil ingestion). The model then calculated pollutant ingestion due to soil ingestion. Inhalation intakes were calculated using USEPA, Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). The following sections describe the model's calculations, assumptions made, and the results in detail.

3.3.2

Deposition Rates and Air-borne Concentrations

ERM modeled the Laidlaw Thermal Treatment facility using a 1 g/sec emission rate for each of 20 burners or a facility-wide emission rate of 20 g/sec. This modeling approach is more conservative than assuming a 1 g/sec emission rate from the site and modeling the site from the center of the concrete burn pad. To keep the health and ecological impact

calculations as straight-forward as possible, ERM converted all impacts to a unitized basis (1 g/sec). This results in an equivalent impact estimate since:

$$\frac{20 * \mu\text{g}/\text{m}^3}{20 \text{ g/sec}} = \frac{\mu\text{g}/\text{m}^3}{1 \text{ g/sec}} = \frac{(\text{Impact Metal } i, \mu\text{g}/\text{m}^3)}{(\text{Emission Rate Metal } i, \text{g/sec})}$$

Thus, for use in the human exposure assessment, the values from the ISCST2 modelling were divided by a factor of twenty to convert all impacts to a unitized basis of 1 g/sec.

Using the emission rates from Section 3.1 and fenceline ISCST2 modeling results, the annual deposition rate and airborne-concentration of each constituent for the entire facility were calculated using the following equations:

$$\text{Deptot} = \frac{\text{Depwet} + \text{Depdry}}{20} * \text{Emissions}$$

$$\text{Concentot} = \frac{\text{Concenvap} + \text{Concenpart}}{20} * \text{Emissions}$$

where

Deptot = total annual maximum deposition rate (g/m²-yr)

Depwet = wet annual maximum unit deposition rate (g/m²-yr)

Depdry = dry annual maximum unit deposition rate (g/m²-yr)

Emissions = emissions rate for entire facility (g/sec)

Concentot = total airborne concentration (μg/m³)

Concenvap = vapor unit concentration (μg/m³)

Concenpart = particulate unit concentration (μg/m³)

For this exposure assessment, all deposition was assumed to be in the form of dry deposition because the facility will not operate during precipitation; thus, the wet deposition factor was set to zero. Pollutants from the treatment units would be emitted as vapors, particulates, or combinations of both. Pollutants with low saturation vapor pressures (e.g. metals) are emitted almost entirely as particulates. Highly volatile constituents are emitted almost entirely as a vapor with no particulate matter. Thus, for all of the metals with the exception of mercury, the airborne concentration was based on the metals all being in the particulate phase. Mercury would be present in the vapor phase only. As

recommended in the Addendum (1993) to the Indirect Exposure Document, vapors are assumed not to be subject to deposition.

The resultant calculations for the total annual maximum deposition rate and total air-borne concentration of the constituents are presented in Tables 3-3-1 and 3-3-2.

3.3.3 *Concentrations of Pollutants in Soil*

The EPA methodology (1990) assumes that chemicals are lost from soil. Chemical constituents could be subject to loss from the soil by leaching, degradation, volatilization, runoff, and erosion. Loss rates for leaching only was incorporated into this assessment. Table 3-3-3 presents the calculation of the soil loss coefficient used in the subsequent calculations to assess human ingestion intake. The soil loss coefficient due to leaching was calculated based on the following equation:

$$k_{sl} = \frac{P + I - E_v}{\theta * Z * (1 + (BD * K_d / \theta))}$$

where

k_{sl} = soil loss coefficient due to leaching (1/yr)

P = average annual precipitation (142.24 cm/yr)

I = average annual irrigation (0 cm/yr)

E_v = average annual evapo-transpiration (115.57 cm/yr)

θ = soil volumetric water content (0.0821 mL/cm³)

Z = soil depth (1 cm)

BD = bulk density of soil (1.5 g/cm³)

K_d = soil-water partition coefficient (chemical specific, mL/g)

Values for K_d were found in Baes et al. (1984). Values for soil volumetric water content, bulk density, and soil depth for ingestion were default values as listed in the Indirect Exposure Document. Precipitation and evapotranspiration data are based on average values for Alexandria, Louisiana and Lake, Louisiana.

Soil concentrations for the individual metals were calculated using the loss coefficients in Table 3-3-3 using the following equation:

$$Sc = \frac{(Dep_{dry} + Dep_{wet}) * (1 - e^{-(k_{sl} * T_c)}) * 100}{Z * BD * k_{sl}}$$

Table 3-3-1
Deposition Rates

Laidlaw Environmental Services, Inc.

Chemical	Emissions (g/sec)	Wet		Wet		Dry		Dry		Total	
		Annual Max. Unit Dep. Rate*	(g/m2-year)	Annual Max. Dep. Rate	(g/m2-year)	Annual Max. Unit Dep. Rate*	(g/m2-year)	Annual Max. Dep. Rate	(g/m2-year)	Annual Max. Dep. Rate	(g/m2-year)
Inorganic Elements											
Al	6.48E+00	0		0.00E+00		0.625		4.05E+00		4.05E+00	
Ba	5.18E-01	0		0.00E+00		0.625		3.24E-01		3.24E-01	
Be	8.64E-04	0		0.00E+00		0.625		5.40E-04		5.40E-04	
Cr	6.05E-04	0		0.00E+00		0.625		3.78E-04		3.78E-04	
Cu	8.64E-02	0		0.00E+00		0.625		5.40E-02		5.40E-02	
Hg	2.50E-01	0		0.00E+00		0		0.00E+00		0.00E+00	
Ni	9.50E-02	0		0.00E+00		0.625		5.94E-02		5.94E-02	
Pb	8.03E-01	0		0.00E+00		0.625		5.02E-01		5.02E-01	
Sb	8.64E-02	0		0.00E+00		0.625		5.40E-02		5.40E-02	
Se	2.59E+00	0		0.00E+00		0.625		1.62E+00		1.62E+00	
Zn	8.64E-02	0		0.00E+00		0.625		5.40E-02		5.40E-02	

* Based on an emissions rate of 1 g/sec

Table 3-3-2
Air-borne Concentrations
Laidlaw Environmental Services, Inc.

Chemical	Emission Limit (g/sec)	Vapor Unit Concentration* (µg/m3)	Maximum Vapor Concentration (µg/m3)	Particulate Unit Concentration* (µg/m3)	Maximum Particulate Concentration (µg/m3)	Total Airborne Concentration (µg/m3)
<i>Inorganic Elements</i>						
Al	6.48E+00	0	0.00E+00	1.285	8.32E+00	8.32E+00
Ba	5.18E-01	0	0.00E+00	1.285	6.66E-01	6.66E-01
Be	8.64E-04	0	0.00E+00	1.285	1.11E-03	1.11E-03
Cr	6.05E-04	0	0.00E+00	1.285	7.77E-04	7.77E-04
Cu	8.64E-02	0	0.00E+00	1.285	1.11E-01	1.11E-01
Hg	2.50E-01	1.285	3.22E-01	0	0.00E+00	3.22E-01
Ni	9.50E-02	0	0.00E+00	1.285	1.22E-01	1.22E-01
Pb	8.03E-01	0	0.00E+00	1.285	1.03E+00	1.03E+00
Sb	8.64E-02	0	0.00E+00	1.285	1.11E-01	1.11E-01
Se	2.59E+00	0	0.00E+00	1.285	3.33E+00	3.33E+00
Zn	8.64E-02	0	0.00E+00	1.285	1.11E-01	1.11E-01

* Based on an emissions rate of 1 g/sec

Table 3. Calculation of the Soil Loss Coefficient for z=1 cm (ingestion by animals and grazing animals)

P (Ave. annual precip, cm/yr)	I (Ave. annual irrigation, cm/yr)	Ev (Ave. annual evapo- transpiration, cm/yr)	θ (Soil volumetric water content, ml/cm ³)	Z (Soil depth, cm)	BD (Bulk density) (g/cm ³)	Kd* (ml/g)	ksl (Soil loss due to leaching)	kgrv (Soil loss deg & vol)	ks (Soil loss all processes) (/year)	Constituent
142.24	0	115.57	0.0821	1	1.5	1500	1.19E-02	0	1.19E-02	Al
142.24	0	115.57	0.0821	1	1.5	60	2.96E-01	0	2.96E-01	Ba
142.24	0	115.57	0.0821	1	1.5	650	2.74E-02	0	2.74E-02	Be
142.24	0	115.57	0.0821	1	1.5	850	2.09E-02	0	2.09E-02	Cr
142.24	0	115.57	0.0821	1	1.5	35	5.08E-01	0	5.08E-01	Cu
142.24	0	115.57	0.0821	1	1.5	10	1.78E+00	0	1.78E+00	Hg
142.24	0	115.57	0.0821	1	1.5	150	1.19E-01	0	1.19E-01	Ni
142.24	0	115.57	0.0821	1	1.5	900	1.98E-02	0	1.98E-02	Pb
142.24	0	115.57	0.0821	1	1.5	45	3.95E-01	0	3.95E-01	Sb
142.24	0	115.57	0.0821	1	1.5	300	5.93E-02	0	5.93E-02	Se
142.24	0	115.57	0.0821	1	1.5	40	4.45E-01	0	4.45E-01	Zn

*For inorganic compounds, Kd values were found in Bues et. al., A Review and Analysis of Parameters for Assessing Transport of Environmentally Released radionuclides through Agriculture. Prepared for US Dept. Of Energy, ORNL-5/86, September 1984

**Precipitation and Evaporation data are based on average values for Alexandria, Louisiana and Lake, Louisiana.

where

S_c	=soil concentration of pollutant after total time period of deposition ($\mu\text{g pollutant/g soil}$)
T_c	=total time period over which deposition occurs (30 yr)
Z	=soil depth (1 cm)
BD	=bulk density of soil (1.5 g/cm^3)
Dep_{wet}	=wet annual maximum unit deposition rate ($\text{g/m}^2\text{-yr}$)
Dep_{dry}	=dry annual maximum unit deposition rate ($\text{g/m}^2\text{-yr}$)
k_{sl}	=soil loss coefficient due to leaching ($1/\text{yr}$)

A time period of 30 years was used based on discussions in the Indirect Exposure Document (1990) and its Addendum (1993). Soil concentrations are presented in Table 3-3-4.

3.3.4 Soil Ingestion

Soil or wind-blown particles may adhere to skin on the hands and forearms and/or become entrapped under fingernails. Subsequent hand to mouth activity associated with eating or smoking may allow for incidental sediment ingestion. An ingestion factor was calculated and then multiplied by the soil concentration of the constituent (Table 3-3-4) to estimate the ingestion intake of an individual. Using the following equation from USEPA, Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A), the total intake from soil ingestion was calculated:

$$\text{Ingestion Intake} = \text{ING}_{\text{carc/noncarc}} * C_s$$

and

$$\text{ING}_{\text{carc/noncarc}} = \frac{\text{IR} * \text{EF} * \text{ED}}{\text{BW} * \text{AT}_{\text{carc/noncarc}}}$$

where:

Ingestion Intake	=ingestion exposure (mg/kg-day)
C_s	=soil concentration (mg/kg)
$\text{ING}_{\text{carc/noncarc}}$	=ingestion factor ($1/\text{day}$)
IR	=ingestion rate (100 mg/day)
EF	=exposure frequency (260 events/yr)
ED	=exposure duration (30, yr)

Table 3-3-4. Soil Concentration for Soil Ingestion by Humans and Grazing Animals

Constituent	Tc (Total time period for deposition, yrs) *	Sc (Soil conc human ingestion, µg/g)
Al	30	6.81E+03
Ba	30	7.29E+01
Be	30	7.37E-01
Cr	30	5.61E-01
Cu	30	7.08E+00
Hg	30	0.00E+00
Ni	30	3.24E+01
Pb	30	7.58E+02
Sb	30	8.15E+01
Se	30	2.73E+02
Zn	30	5.05E+01

*A Tc of 30 years was selected based on the discussions in USEPA, Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions, EPA/600/6-90/003 and USEPA, Addendum: Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions.

BW =body weight (70kg)
 AT_{carc/noncarc} =averaging time (day)

The averaging time for noncarcinogens is equivalent to the total duration over which an exposure is experienced (here, 30 years * 365 days/year), whereas the averaging time for carcinogens is equivalent to a lifetime (70 years * 365 days/year). The values for ingestion rate and body weight are default values listed in the Indirect Exposure Document. An exposure frequency of 260 days/year (5 days per week for 52 weeks) was selected as a conservative estimate of exposure for a maximally exposed individual based on the following reasons: the facility may not operate when precipitation occurs, individuals may not venture outside during inclement weather conditions, and limited agricultural and residential use exist in proximity to the site. A total time period of 30 years for exposure was selected based on the Indirect Exposure Document. In this document, EPA recommends 30 years as a high-end estimate of exposure.

Table 3-3-5 presents the parameters involved in the calculation of the soil ingestion factor and the ingestion intake values for carcinogens and non-carcinogens.

3.3.5 *Inhalation Exposure*

Daily intake from inhalation exposure was calculated using the air-borne concentrations from Table 3-3-2. Table 3-3-6 presents the daily intake through inhalation calculated from the following equation from USEPA, Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A):

$$\text{Inh. intake}_{\text{carc/noncarc}} = \frac{\text{Concent}_{\text{tot}} * \text{IR} / 3 * \text{EF} * \text{ED}}{\text{BW} * \text{AT}_{\text{carc/noncarc}}}$$

where

Inh. intake_{carc/noncarc} =intake due to inhalation (mg/kg-day)
 Concent_{tot} =total airborne concentration (µg/m³)
 IR =inhalation rate (20 m³/day)
 EF =exposure frequency (260 day/yr)
 ED =exposure duration (30 yr)
 BW =body weight (70 kg)
 AT_{carc/noncarc} =averaging time (day)

Table 3-1. Soil Ingestion Factor and Direct Contact Dose (via ingestion)

Exposure Route: Population Subgroup Lifetime	Ingestion (Carcinogens)		Soil Ingestion Factor				
	IR mg/day 100	ED years 30	EF days/year 260	CF kg/mg 0.000001	BW kg 70	AT days 25550	log Factor (lb) 4.36E-07
Exposure Route: Population Subgroup Adults	Ingestion (Non-Carcinogens)		EF days/year 260	CF kg/mg 0.000001	BW kg 70 <td>AT days 10957.5<td>log Factor (lb) 1.02E-06</td></td>	AT days 10957.5 <td>log Factor (lb) 1.02E-06</td>	log Factor (lb) 1.02E-06
	IR mg/day 100	ED years 30					
Direct Contact Dose							
Chemical	Concentration (mg/kg)	Carcinogens:		Noncarcinogens:		Direct Contact Dose (mg/kg/day)	
		Direct Contact Factor:	Dose (mg/kg/day)	Direct Contact Factor:	Dose (mg/kg/day)		
Al	6.81E+03	4.36E-07	2.97E-03	1.02E-06	6.93E-03		
Ba	7.29E+01	4.36E-07	3.18E-05	1.02E-06	7.41E-05		
Be	7.37E-01	4.36E-07	3.21E-07	1.02E-06	7.49E-07		
Cr	5.61E-01	4.36E-07	2.45E-07	1.02E-06	5.71E-07		
Cu	7.08E+00	4.36E-07	3.09E-06	1.02E-06	7.20E-06		
Hg	0.00E+00	4.36E-07	0.00E+00	1.02E-06	0.00E+00		
Ni	3.24E+01	4.36E-07	1.42E-05	1.02E-06	3.30E-05		
Pb	7.58E+02	4.36E-07	3.30E-04	1.02E-06	7.70E-04		
Sb	8.15E+01	4.36E-07	3.55E-05	1.02E-06	8.28E-05		
Se	2.73E+02	4.36E-07	1.19E-04	1.02E-06	2.78E-04		
Zn	5.05E+01	4.36E-07	2.20E-05	1.02E-06	5.13E-05		

Table 3-3-6. Inhalation Intake

Chemical	Airborne Concentration (ug/m3)	Intake(carc) (Inhalation) (mg/kg/day)	Intake(noncarc) (Inhalation) (mg/kg/day)	RSD* (ug/m3)
Al	8.32E-00	2.42E-04	5.65E-04	
Ba	6.66E-01	1.94E-05	4.52E-05	
Be	1.11E-03	3.23E-08	7.53E-08	4.20E-03
Cr	7.77E-04	2.26E-08	5.27E-08	8.30E-04
Cu	1.11E-01	3.23E-06	7.53E-06	
Hg	3.22E-01	9.36E-06	2.18E-05	
Ni	1.22E-01	3.55E-06	8.28E-06	4.20E-02
Pb	1.03E+00	3.00E-05	7.00E-05	
Sb	1.11E-01	3.23E-06	7.53E-06	
Se	3.33E+00	9.68E-05	2.26E-04	
Zn	1.11E-01	3.23E-06	7.53E-06	

* Values for RSD, Risk-specific Dose, is based on a 10-5 risk, were found in EPA, Federal Register, 40 CFR Part 260, et al., February 1991.

BW, EF, ED, and AT are the same parameters with the same respective default values discussed previously. The factor of 3 was added to account for the fact that the facility can only run 8 hours per day; if a maximally exposed person inhales a total of 20 m³ air per day (default value listed in RAGS) and the facility can only treat materials for one third of the day, the ingestion rate of 20 m³ per day must be adjusted to 20/3 m³ per day.

3.4

RISK CHARACTERIZATION

Carcinogenic and non-carcinogenic human exposure potential for the facility is shown in Tables 3-4-1 and 3-4-2. The values listed in the intake tables are based on soil and air concentrations derived from the ISCST2 model. The soil and total airborne concentrations derived from the model were compared with background soil and air concentrations in order to put the risk assessment in perspective. If resultant concentrations in various media do not exceed background concentrations, facility operations should not pose a risk to human populations. This comparison of concentrations is presented in Table 3-4-3. In the cases of beryllium, chromium, and copper, the total airborne concentrations produced by the thermal treatment units are less than the background concentrations. The resultant soil concentrations for barium, beryllium, chromium, copper, nickel, and zinc are also less than background soil concentrations.

3.4.1

Non-Carcinogenic Risk

For toxicants with threshold dose-responses (non-carcinogens), daily intake is compared with the reference dose for chronic exposure (RfD) to determine if the contaminant poses a risk to human health. Comparisons were made with both oral and inhalation RfDs, if the values were available. Table 3-4-2 presents the reference doses for oral and inhalation routes adjacent to the respective intake value for each constituent.

Inhalation intakes for barium, mercury, and lead fall below each metal's respective inhalation reference dose. For the ingestion pathways, ingestion intakes for all of the metals also are less than each metal's respective ingestion reference dose. In the cases of barium, beryllium, chromium, copper, nickel, and zinc, intakes are orders of magnitude less than the reference doses.

3.4.2

Carcinogenic Risk

For carcinogens, the daily intake is used to estimate excess risk. The excess risk is defined as the incremental lifetime cancer risk above background occurring in a hypothetical population in which all individuals are

Table 3-4-1. Total Carcinogenic Intakes

Chemical	Intake (Inhalation) (mg/kg/day)	Intake (Ingestion) (mg/kg/day)
Carcinogenic		
Al	2.42E-04	2.97E-03
Ba	1.94E-05	3.18E-05
Be	3.23E-08	3.21E-07
Cr	2.26E-08	2.45E-07
Cu	3.23E-06	3.09E-06
Hg	9.36E-06	0.00E+00
Ni	3.55E-06	1.42E-05
Pb	3.00E-05	3.30E-04
Sb	3.23E-06	3.55E-05
Se	9.68E-05	1.19E-04
Zn	3.23E-06	2.20E-05

Table 3-4-2. Total Non-Carcinogenic Intakes

Chemical	Intake (Inhalation) (mg/kg/day)	Rfd * (Inhalation) (mg/kg/day)	Intake (Soil Ingestion) (mg/kg/day)	RfD * Ingestion (mg/kg/day)
Al	5.65E-04	4.29E-02	6.93E-03	
Ba	4.52E-05	5.00E-04	7.41E-05	7.00E-02
Be	7.53E-08		7.49E-07	5.00E-03
Cr	5.27E-08		5.71E-07	5.00E-04
Cu	7.53E-06		7.20E-06	5.00E-03
Hg	2.18E-05	8.57E-05		3.71E-02
Ni	8.28E-06		3.30E-05	2.00E-02
Pb	7.00E-05	4.29E-04	7.70E-04	
Sb	7.53E-06		8.28E-05	4.00E-04
Se	2.26E-04		2.78E-04	5.00E-03
Zn	7.53E-06		5.13E-05	3.00E-01

*For references, see Table 3-3-2, Non-Carcinogenic Toxicological Indices

Table 3-4-3. Comparison of Soil and Air Concentrations to Background Concentrations

Chemical	Total Airborne Concentration (µg/m ³)	Louisiana's Highest Annual Airborne Concentration (µg/m ³)	Soil Concen. Z=20 cm (µg/g)	Mean Soil Concen. for Eastern U.S. (µg/g)
Al	8.32E+00		4.01E+02	5.70E+00
Ba	6.66E-01	8.00E-03	2.62E+01	4.20E+02
Be	1.11E-03	3.00E-02	5.29E-02	8.50E-01
Cr	7.77E-04	6.00E-03	3.72E-02	5.20E+01
Cu	1.11E-01	1.96E-01	3.78E+00	2.20E+01
Hg	3.22E-01		0.00E+00	1.20E-01
Ni	1.22E-01	5.00E-03	5.44E+00	1.80E+01
Pb	1.03E+00	1.00E-01	4.95E+01	1.70E+01
Sb	1.11E-01	7.00E-03	4.07E+00	7.60E-01
Se	3.33E+00	3.00E-03	1.55E+02	4.50E-01
Zn	1.11E-01	7.10E-02	3.94E+00	5.20E+01

*Mean soil concentrations for the eastern United States were taken from Shacklette and Boerngen (1984).

**Airborne concentrations for Louisiana were taken from Aerometric Information Retrieval System (AIRS) with the exception of the values for Ba, Sb, and Se. Se and Sb values are from Schroeder et al. (1987) and Ba is from Davidson et al. (1985).

exposed continuously to a concentration equal to the daily intake of the contaminant (EPA, 1990). The excess risk is derived from the daily incremental dose of the contaminant above background and the human cancer slope factor. Table 3-4-4 shows the risk associated with each constituent for which a cancer slope factor exists and the total risk for the maximally exposed individual.

Total carcinogenic risk is estimated at less than 6 in one million, which is less than EPA's target risk level of 10 in one million. Nickel dominates inhalation risk with a risk of approximately 3 in a million. Total inhalation risk equals approximately 4 in one million. The risk associated with the ingestion of beryllium and the total ingestion risk equal approximately 1.5 in a million. The ingestion risk associated with the other metals could not be estimated due to a lack of toxicological data.

3.5 **UNCERTAINTY ANALYSIS**

Each step in the risk assessment process contains sources of uncertainty due to specific assumptions and extrapolations. The following sections describe sources of uncertainty for each step in the risk assessment process, and their potential effect on the outcome of the overall risk evaluation. As indicated, the use of a "reasonable worst-case" scenario has led to an evaluation that is conservative in nature.

3.5.1 ***Maximum Mass Emissions Estimates and Air Dispersion Modeling***

3.5.1.1 ***Maximum Mass Emission Estimates***

In the development of acceptable emission rates, ERM conservatively assumed that all metals except mercury have a mass emission rate of 30 percent. Assigning all metals with the exception of mercury this mass emission rate is an inherently conservative assumption because lead is a relatively volatile metal.

LES Thermal Treatment facility personnel estimate that the realistic maximum anticipated metal throughputs are less than 20 tons per year. Thus, the facility was modeled using metal emission rates which are conservatively over six times the maximum anticipated metal throughputs in any single year.

3.5.1.2 ***Air Dispersion Modeling***

ERM used a modeling approach that is more conservative than assuming a 1 g/sec emission rate from the site and modeling the site from the center of the concrete burn pad. The Laidlaw Thermal Treatment facility was

Table 4-4. Summary of Potential Carcinogenic Risks

Chemical	Inhalation CSF 1/(mg/kg/day)	Inhalation Intake (mg/kg/day)	Inhalation Risk	Ingestion Intake (mg/kg/day)	Ingestion CSF 1/(mg/kg/day)	Ingestion Risk
<i>Metals</i>						
Al		2.42E-04		2.97E-03		
Ba		1.94E-05		3.18E-05		
Be	8.40E+00	3.23E-08	2.71E-07	3.21E-07	4.30E+00	1.38E-06
Cr	4.10E+01	2.26E-08	9.26E-07	2.45E-07		
Cu		3.23E-06		3.09E-06		
Hg		9.36E-06		0.00E+00		
Ni	8.40E-01	3.55E-06	2.98E-06	1.42E-05		
Pb		3.00E-05		3.30E-04		
Sb		3.23E-06		3.55E-05		
Se		9.68E-05		1.19E-04		
Zn		3.23E-06		2.20E-05		
		Total	4.18E-06	Total	Total	1.38E-06

TOTAL RISK 5.56E-06

modeled using a 1 g/sec emission rate for each of 20 burners or a facility-wide emission rate of 20 g/sec.

A reflection coefficient of zero was assumed for all particle sizes. This assumption results in the maximum possible deposition and therefore a conservative estimate of deposition rates.

3.5.2 *Hazard Identification*

The list of metals evaluated is representative of those potentially released from the facility as a result of incineration operations. The exclusion of As and Cd from the list is justified based on a review of incinerator wastestreams which indicated the absence of these metals. It is possible that these metals may be present in trace quantities and that small releases may occur; however, the potential risk associated with these trace releases is expected to be negligible in comparison to other constituents being evaluated.

3.5.3 *Toxicological Assessment*

The toxicological values used in this evaluation are derived from either animal or epidemiological dose-response studies. The extrapolation of dose-response data from animals to humans, or from one route of exposure to another is a source of uncertainty. However, safety factors and/or modifying factors applied in order to make the conversions tend to be conservative in nature, thus leading to conservative toxicological values, and, in turn, conservative estimates of risk.

In terms of the form, or state, of chemicals used in this evaluation, the consideration of chromium as totally in the hexavalent form is a conservative assumption which leads to a conservative estimate of risk. Hexavalent-Cr has an Oral RfD of $5.00 \text{ E-}03$ while the Oral RfD for Trivalent-Cr is $1.00 \text{ E+}00$. In addition, Hexavalent-Cr is considered a carcinogen while Trivalent-Cr is not.

Because no data exist to develop an oral RfD for other nickel compounds or nickel dust, the oral RfD for a soluble nickel compound, NiSiO_4 , was used for this assessment. Nickel emissions from most combustion sources are likely to be in the insoluble form. Thus, utilization of an RfD based on soluble nickel compounds leads to a conservative estimate of risk from exposure to nickel.

3.5.4 *Exposure Assessment*

Many of the values chosen for the parameters used in the human exposure assessment were conservative in nature. The following list includes a

summary of conservative assumptions used to complete the screening analysis:

- The EPA methodology (1990, 1993) assumes that chemicals are lost from the soil by leaching, degradation, volatilization, runoff, and erosion. For the constituents involved in this analysis, degradation and volatilization losses are not appropriate. However, only loss rates due to leaching were incorporated into this study. Thus, this assumption leads to a conservative estimate of soil concentrations.
- A total time period of 30 years for exposure was selected based on discussions in the Indirect Exposure Document (1990) and its Addendum (1993). This value was the EPA's recommendation as a high-end estimate of exposure. Selection of this value is extremely conservative since many individuals within the exposed population may reside in the area for a much shorter time.
- An exposure frequency of 260 events per year was selected based on discussions in Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part A. This guidance recommends a default frequency of 365 events per year, but suggests considering local weather conditions. A conservative exposure frequency of 260 events per year was chosen based on the following reasons: the facility may not operate when precipitation occurs, individuals may not venture outside during inclement weather conditions, and limited agricultural and residential use exist in proximity to the site.

4.1

PROBLEM FORMULATION

4.1.1

Introduction

The ecological risk assessment (ERA) developed for the Laidlaw Environmental site focuses on the qualitative evaluation of potential ecological risk. This ERA is considered a reasonable worst-case screening assessment to determine the incremental risk of particulate emissions from the facility. Existing ecological and toxicological data and air emissions modeling results were utilized to describe the site's ecology and to characterize possible exposures and toxicological effects. Characterization of risks was determined through the identification of potential exposure pathways to ecological receptors and an estimation of possible effects associated with such exposures was made.

This ERA was conducted in accordance with the guidance presented in, "Framework for Ecological Risk Assessment," (EPA/630/R-92/001). The objectives of this ERA were:

- Describe the ecology of the property by characterizing major habitat types and associated wildlife to their preferred habitats
- Assessment of the potential risk to terrestrial receptors from eleven (11) metals which are potentially associated with the facility's emissions
- Integration of particulate modeling data to toxicological effects data and exposure and pathways analysis
- Utilization of air dispersion model results to determine the distribution and extent of the particulate emissions, deposition, and uptake

The ERA consisted of the following tasks:

- Characterization of site ecosystems, including vegetative communities
- Modeling data review
- Receptor characterization
- Exposure assessment
- Toxicity assessment

- Risk characterization
- Uncertainties analysis

Assumptions were made in order to conduct the ERA. These assumptions were based on best professional judgment. It must be noted that no site observations nor surveys to collect ecological data were conducted by the risk assessors. Assumptions were necessary to restrict the range of analyses and conduct a screening level ERA. The assumptions were:

- Exposure at the property fence line reflects the "worst case" risk of off-property regional wildlife
- Wildlife exposure within the inner fence line is minimal, due to heavy human usage and site development
- Aquatic exposure is minimal due to the headwater, probable intermittent nature, of the small tributaries draining the site
- Use of conservative exposure and toxicity values (i.e. the lowest value available was utilized) reflect "worst case conditions"

4.1.2 *Site Description and Topography*

As indicated in Section 1.1, the site encompasses approximately 700 acres in Grant Parish, approximately 3 miles north of Colfax, Louisiana (See Figures 1-1 and 1-2). The central portion of the property is located on a topographic high point. The majority of the property is characterized as hilly (5-30 percent slopes) with natural drainage swales and shallow ravines. The property occurs mainly on terrace uplands according to the Soil Survey of Grant Parish (Kilpatrick et al., 1986). The highest elevation is 220 feet above mean sea level (fmsl) located near the center of the property and the lowest elevation is 110 fmsl located at the southeastern corner of the property within a valley.

Surface water runoff flows in multiple directions away from the central portion of the property. The property serves as the headwaters for several small tributaries. Along the north and western portion, the tributaries flow into the Summerfield Branch, a small stream that eventually flows into the Bayou Grappe. Along the southwest side of the property, the tributaries flow south directly into the Bayou Grappe which flows into other bayous and eventually into the Red River. Along the east and southeast side of the property, small tributaries flow toward the southeast into the Valentine Bayou which flows into the Bayou Grappe and Sugarhouse Bayou. Iatt Lake is a man-made lake located approximately 2 miles east of the property. The 7,100 acre lake was impounded in 1956 when a spillway was constructed across an existing river floodplain (Bayou Rigolette). Approximately 80 percent of the Iatt Lake consists of

timber such as bald cypress and tupelo and the remaining portion is open water.

The USGS topographic quadrangle map (Colfax, LA), aerial photographs from the soil survey, information gathered from the Louisiana Department of Wildlife and Fisheries (LADWF) and Northwestern Louisiana State University, and a wetland delineation report prepared for the facility were used to characterize the existing habitat and wildlife present within the property and the surrounding area. ERM did not conduct a field visit or survey any portion of the site in the preparation of this ERA.

The dominant habitat cover-type of the property and surrounding area consists of a pine-upland hardwood forest. Within a mile of the site, there are very few areas that are not forested. A few wetlands occur along the tributaries located within and outside of the property boundary. Agriculture is the main land use approximately one mile south between an identified landmark known as, The Rock, and the Red River which is further south. The agricultural land occurs within the level floodplain area of the Red River. A description of the pine-upland hardwood forest and the wetland habitats within and surrounding the Laidlaw property is presented in the following section.

The Kisatchie National Forest comprises approximately 600,000 acres of federally owned land and is made up of six geographically separate Ranger Districts located within west-central and northern Louisiana. The Catahoula Ranger District is comprised of approximately 119,260 acres and is the closest district to the Laidlaw property. The western boundary of the Catahoula District is located approximately 6 miles east of the property. The majority (64 percent) of the national forest is covered with yellow pine (loblolly, shortleaf, and slash) and approximately 16 percent is longleaf pine. Pine forests are interspersed with hardwood stands and flowering species such as dogwood, redbud, and magnolia. Hardwoods such as hickory, cypress, oak, and gum comprise the bottomlands within the floodplains. Natural communities of the national forest include: herbaceous bog; baygall community; cypress-tupelo swamp; bottomland hardwood forest; mixed hardwood-loblolly forest; longleaf pine savannah; loblolly-shortleaf pine forest (pine-oak); and sandy woodlands.

4.13 *Habitat Cover-type Descriptions*

4.13.1 *Pine-Upland Hardwood Forest*

The major vegetative community that occurs within the property and the surrounding area is the pine-upland hardwood forest. Loblolly pine, shortleaf pine and longleaf pine are the three dominant pine species

occurring within this cover-type. The dominant hardwood species consist of blackjack oak, southern red oak, post oak, hickories, sweetgum, magnolias, black gum, flowering dogwood, and red maple. The black jack oak is among the most common hardwood within the property, occurring on the ridge tops, side-slopes and next to the drainages. Hardwoods constitute approximately 45 percent of the total basal area (Reed, 1981) within the loblolly-shortleaf pine forests found within the Catahoula Ranger District. Dominant understory vegetation consist of yellow jasmine, blackberry, and waxmyrtle. The overhead canopy is generally thick leading to a sparse growth of herbaceous vegetation within the ground layer. In more open canopy areas, bracken fern and partridge-berry are common ground covers.

Approximately 15 years ago, the majority of the property and the surrounding area was logged for commercial timber. Mainly hardwoods were logged, however, within smaller areas, selected pine trees were harvested for pulp wood. In the surrounding area, the forest is managed for the production of timber and pulp wood. Clearcutting and prescribed burning are extensively practiced. Regeneration is often done by seed dispersal or by planting.

4.1.3.2 *Developed or Disturbed Land*

Generally, the forest surrounding the property is managed for the production of timber and pulp wood. Commercial timber companies own a majority of the surrounding area. Dirt roads and logging trails are common throughout this area. The largest town closest to the Laidlaw property is Colfax which is located approximately 3 miles to the south. There are several small areas within the vicinity of the property where a number of houses occur, however these areas are not considered villages or towns. The closest concentration of houses occurs approximately 3,000 feet east of the southeastern corner of the property boundary.

According to the USGS topographic map and the soil survey aerial photographs, there are no areas which appear to be disturbed (i.e., land dumping, gravel or sand pits) within the site and surrounding area.

4.1.3.3 *Wetlands and Other Sensitive Areas*

A formal wetland delineation was conducted within the 43 acre facility operations area by Espey, Huston and Associates, Inc. The report concluded that no wetland areas were located within this area.

According to the U. S. Fish and Wildlife Service (USFWS) National Wetland Inventory Map (NWI), no wetlands occur within the 43 acre facility boundary, however, a portion of a large palustrine forested

wetland occurs within the southeastern section of the property boundary. This forested wetland is located along one of the headwater tributaries that flows into Valentine Bayou. Vegetation likely to dominate this forested wetland would include red maple, sweetgum, water oak, black gum, loblolly pine, and blueberry. No other wetland areas identified by the NWI map are located within the property boundary.

No other sensitive areas have been identified within the property boundary.

4.1.3.4 *Potential Wildlife Species Associated with Cover-types*

Several sources of information were used to generate a list of species that may occur within the forested habitat found on the property. A list of vertebrates of Grant Parish was obtained from the LADWF. This list includes species found in all types of habitats but does not include all species found within the parish. This list was modified and supplemented using a number of studies conducted to characterize the wildlife (amphibians and reptiles, birds, and mammals) associated with a loblolly-shortleaf pine-upland hardwood forest. These surveys were conducted within the Catahoula Ranger District of the Kisatchie National Forest located approximately 10 miles east of the property. The loblolly-shortleaf pine-hardwood forest of the study areas are very similar to the habitat type found on the property. Other information was gathered from the Kisatchie National Forest Final Land and Resource Management Plan and the Final Environmental Impact Statement.

A list of wildlife species generated from the above references is presented in Table A3-1 as part of Appendix 3. These species are known to occur within Grant Parish and a number of them may occur within the pine-upland hardwood forest of the property.

A total of 20 amphibians, 35 reptiles, 103 birds, and 48 mammals were identified in the surveys conducted within the pine-upland hardwood community of the Kisatchie National Forest. Most of these species would be expected to occur within the 700 acre Laidlaw property. Thirty of the bird species were observed less than 3 times and may only represent transient species. These species would be less likely to occur within the Laidlaw property.

Table A3-1 also includes a list of 80 species of fish known to occur within all of Grant Parish. This list includes species that inhabit lakes, large rivers, and streams. Only small headwater streams occur within the property, therefore, the number of fish species that may occur within the property would be greatly reduced. The U.S. Forest Service designated the following predator species as indicator species for streams located

within the Catahoula Ranger District: largemouth bass, spotted bass, bluegill, flier, dollar sunfish, redbfin pickerel chain pickerel, striped shiner, pirate perch, and creek chub. These streams are generally slow flowing, shallow with frequent deep holes, clay bottom covered with silt and soft mud and are generally turbid.

4.1.3.5 *Threatened and Endangered Species*

According to the data base managed by the LADWF, there are no rare, threatened, or endangered plants, animals, or natural communities that occur on the 700 acre Laidlaw property. The federal status of the wildlife species of Grant Parish is presented in Table A3-1. Two species, the American alligator and the red-cockaded woodpecker, are known to occur within Grant Parish and are federally listed as threatened (by similarity of appearance) and endangered, respectively. The primary concern with the recovery of the American alligator is protection from illegal hunting. It is known to occur within Iatt Lake and the larger slow flowing bayous located south of the property. The alligator is unlikely to inhabit the headwater streams found within the property boundary.

There are two red-cockaded woodpecker breeding areas delineated within the Catahoula Ranger District. The closest site is located approximately 12 miles east of the Laidlaw property. Other areas within the district which are not mapped may be managed as recruitment stands for the red-cockaded woodpecker. The woodpecker is present within 38 percent of the entire Kisatchie National Forest. Most of the colonies are located within the longleaf forest type. The red-cockaded woodpecker prefers open stands of mature (greater than 20 years of age) pines for roosting, foraging, and nesting habitat. The average cavity tree age for this species is about 100 years in longleaf pines and 80 years in other southern pine species.

The data base did determine that the federally threatened Louisiana pearlshell (*Mararitifera hembeli*), a freshwater mussel, is found in small streams to the southeast of the property.

Seven plant species that occur within Grant Parish were identified by the LADWF data base as being rare (Appendix 3 - Table A3-2). None of these species are federally listed as rare, threatened, or endangered. Four of these species: Louisiana blue star; northern burmannia; southern lady's slipper; and, wild coco are known to occur within the Catahoula Ranger District of the Kisatchie National Forest. Portions of the western boundary of the Catahoula Ranger District is located approximately 5 to 6 miles from the Laidlaw property.

4.1.3.6 *Assessment of Stressed Vegetation*

The assessment of stressed vegetation was limited to the review of aerial photographs of the property. According to this review, no areas of stressed vegetation was observed within the property or the surrounding area.

4.1.4 *Hazard Identification*

This ERA is a screening predictive assessment utilizing modeled deposition rates of various metals at the property fence line after 30 years of airborne deposition. Worst-case assumptions were made on food intake and toxicity values to calculate a worst-case exposure scenario. The nature and quantity of the contaminants of concern were estimated based on modeling as described in Section 4.2.2.

4.1.4.1 *Contaminants of Concern*

The contaminants of concern were identified based on the expected deposition of particulate from the proposed burning activities, as previously described in the Human Health Risk Assessment (Section 3). Eleven metals, listed below, were identified as potential contaminants of concern.

- Aluminum
- Antimony
- Barium
- Beryllium
- Chromium
- Copper
- Lead
- Mercury
- Nickel
- Selenium
- Zinc

4.2 *EXPOSURE ASSESSMENT*

4.2.1 *Basis of Exposure Assessment*

For the purposes of the ecological screening assessment, ERM used habitat and species characterization results, presented in Section 4.1, to develop site-specific exposure scenarios for ecological receptors. The extent of

ecological exposure to the contaminants of concern was assessed by evaluating potential bioaccumulation of metals through the food chain. Estimated soil concentrations (from the modelling effort) were used to determine potential metal concentrations within vegetation and invertebrates. Plant and invertebrate concentrations were determined by using appropriate plant and invertebrate (earthworm) uptake factors reported in the literature.

Vertebrate indicator species (e.g. bird, mouse and deer) were then selected to model potential exposure doses received through the ingestion of vegetation and invertebrates which have accumulated metals. In addition, the inadvertent ingestion of soils containing settled particulates was considered as a route of exposure for the indicator species. Factors included in modelling exposure by the selected indicator species include: body weight, diet composition, daily ingestion rate, and other ecological characteristics.

The metals identified in Section 3.2 and their concentrations in soils obtained through the deposition modeling effort described in Section 3.3 were used for the screening assessment. The following sections present detailed descriptions of the methodologies and results of the ecological exposure assessment.

4.2.2

Summary of Modeling Used for Ecological Exposure

The ecological exposure assessment relies heavily on the use of models to evaluate ecological exposure to chemicals emitted. In designing this assessment, models were selected that have been developed, reviewed, and/or recommended by the EPA.

Like the methodology used for the human exposure assessment described in Section 3.4.1, concentrations and deposition rates derived from the ISCST2 modeling were input to a modified version of a food chain model developed at Oak Ridge National Laboratory (Travis et al., 1988) to calculate ecological exposure. For the ecological exposure assessment, the model was used to calculate soil concentrations (for direct ingestion by grazing animals and root uptake by plants) and plant concentrations (forage, leafy vegetables, and fruits).

The model used the unitized deposition rates and concentrations and the emission rates (see Section 3.1 for the derivation of the emission rates) to calculate annual deposition rates and air-borne concentrations. Soil concentrations could then be calculated using the following parameters: deposition rate, facility lifetime, pollutant loss rates from the soil, and the depth of contamination (1 cm for direct soil ingestion and 20 cm for plants

and forage). The model then considered three pathways for contamination of plants:

- root uptake: direct absorption of pollutant from the soil and incorporation into plant tissues;
- deposition: direct deposition and adherence of pollutant particulate onto plant surfaces (leaves, stems, fruits); and
- vapor absorption: absorption of vapor into aerial plant parts.

The following sections describe the model's calculations, assumptions used, and the results in detail.

4.2.3 *Deposition Rates and Air-borne Concentrations*

Deposition rates and air-borne concentrations were estimated using the same methodology as described in Section 3.4.2. The resultant calculations for the total annual maximum deposition rate and total air-borne concentration for the constituents at the facility boundary are presented in Tables 3-4-1 and 3-4-2.

4.2.4 *Cumulative Deposition on Edible Portions of Plants*

Table 4-2-1 shows the results of the calculations of the cumulative deposition of pollutants onto the edible portion of leafy vegetables and fruits, and Table 4-2-2 shows the results of the same calculations for forage. The maximum cumulative deposition onto the plants was calculated using the following equation from EPA (1990):

$$\text{Dep}_{\text{max}} = \text{Dep}_{\text{tot}} * R_f * (1 - e^{(-k_p * T_f)}) / k_p$$

where

Dep_{max} = maximum cumulative deposition on edible portion of plant (g/m²)

Dep_{tot} = yearly deposition rate (g/m²-yr)

R_f = interception fraction (plant specific, unitless)

T_f = exposure period of plant for deposition (plant specific, yr)

k_p = plant surface loss constant (chemical specific, 1/yr)

The interception fraction accounts for the fact that not all of the material deposited on a plant surface will adhere to the surface. Values for the interception fraction of 0.2, 0.04, and 0.6 were selected for leafy vegetables, fruit, and forage based on discussions in Baes et al., 1984. The plant surface loss coefficient measures the amount of contaminant lost from the

Table 2-1. Deposition of Pollutants onto the Edible Portions of Plants

Chemical	Plant Food Group	Dyw (yearly wet deposition rate, g/m ² /yr)	Dyd (Yearly dry deposition rate, g/m ² /yr)	Rp (Interception Fraction for humans plant foods)	Kp (Plant surface loss constant, 1/yr)	TP (Exposure period of plant for deposition, Yrs)	Dip (Max cum deposition onto edible portion of plant, g/m ²) *
Al	leafy Veg Fruit	0.00E+00 0.00E+00	4.05E+00 4.05E+00	0.2 0.04	18 18	0.493 0.164	4.50E-02 8.53E-03
Ba	leafy Veg Fruit	0.00E+00 0.00E+00	3.24E-01 3.24E-01	0.2 0.04	18 18	0.493 0.164	3.60E-03 6.82E-04
Be	leafy Veg Fruit	0.00E+00 0.00E+00	5.40E-04 5.40E-04	0.2 0.04	18 18	0.493 0.164	6.00E-06 1.14E-06
Cr	leafy Veg Fruit	0.00E+00 0.00E+00	3.78E-04 3.78E-04	0.2 0.04	18 18	0.493 0.164	4.20E-06 7.96E-07
Cu	leafy Veg Fruit	0.00E+00 0.00E+00	5.40E-02 5.40E-02	0.2 0.04	18 18	0.493 0.164	6.00E-04 1.14E-04
Hg	leafy Veg Fruit	0.00E+00 0.00E+00	0.00E+00 0.00E+00	0.2 0.04	18 18	0.493 0.164	0.00E+00 0.00E+00
Ni	leafy Veg Fruit	0.00E+00 0.00E+00	5.94E-02 5.94E-02	0.2 0.04	18 18	0.493 0.164	6.60E-04 1.25E-04
Pb	leafy Veg Fruit	0.00E+00 0.00E+00	5.02E-01 5.02E-01	0.2 0.04	18 18	0.493 0.164	5.58E-03 1.00E-03
Sb	leafy Veg Fruit	0.00E+00 0.00E+00	5.40E-02 5.40E-02	0.2 0.04	18 18	0.493 0.164	6.00E-04 1.14E-04
Se	leafy Veg Fruit	0.00E+00 0.00E+00	1.62E+00 1.62E+00	0.2 0.04	18 18	0.493 0.164	1.80E-02 3.41E-03
Zn	leafy Veg Fruit	0.00E+00 0.00E+00	5.40E-02 5.40E-02	0.2 0.04	18 18	0.493 0.164	6.00E-04 1.14E-04

*In calculating Dip, Dyw was multiplied by f_w (fraction of wet deposition that adheres to plant surfaces). As discussed in US EPA, "Appendix: Methodology for assessing health risks associated with indirect exposure to combustor emissions", f_w was set to 1 for dioxins and constituents with log K_{ow} > 3 and 0.1 for metals and constituents with log K_{ow} < 3.

**Rp is based on Baes et al., A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture, Oak Ridge National Laboratory, September, 1984.

***Tp is based on the longest time a food group takes to mature.

Table 2. Cumulative Deposition of Pollutants onto the Edible Portion of Forage Plants

Constituent	Dy (Yearly deposition rate, g/m ² /yr)	Rf (Interception Fraction for animal forage)*	Kp (Plant surface loss constant, 1/yr)**	Tf (Exposure period of plant for deposition, Yrs)***	Df(Max cum deposition onto edible portion of plant, g/m ²)
Al	4.05E+00	0.6	18	0.123	1.20E-01
Ba	3.24E-01	0.6	18	0.123	9.62E-03
Be	5.40E-04	0.6	18	0.123	1.60E-05
Cr	3.78E-04	0.6	18	0.123	1.12E-05
Cu	5.40E-02	0.6	18	0.123	1.60E-03
Hg	0.00E+00	0.6	126.5	0.123	0.00E+00
Ni	5.94E-02	0.6	18	0.123	1.76E-03
Pb	5.02E-01	0.6	18	0.123	1.49E-02
Sb	5.40E-02	0.6	18	0.123	1.60E-03
Se	1.62E+00	0.6	18	0.123	4.81E-02
Zn	5.40E-02	0.6	18	0.123	1.60E-03

*For the derivation of Rf, please see Baes et al., 1984. $Rf = 1 - e^{-(2.88 \cdot Yp)}$ where Yp = yield = 0.31 kg/m²

**Values for Kp were selected based on the 1993 Addendum to the Indirect Exposure Document.

***The value for Tf was taken from the Indirect Exposure Document.

plant surface to wind removal, water removal, and growth dilution. As discussed in the Addendum (1993) to the Indirect Exposure Document (1990), nonvolatile and volatile compounds were assigned k_p values of 18 and 126.5 years⁻¹, respectively. The length of plant exposure is equivalent to the amount of time the edible part of the plant is exposed to direct deposition. Values for T_f of 0.493, 0.164, and 0.123 years were selected for leafy vegetables, fruit, and forage, respectively. A total deposition rate for each constituent were derived from the ISCST2 modeling (Table 3-4-1).

4.2.5 Concentrations of Pollutants in Soil

As discussed in Section 3.4.3, calculation of pollutant concentrations in the soil considers soil loss by leaching, degradation, volatilization, runoff, and erosion. Loss rates for leaching only was incorporated into this assessment. Table 3-4-3 presents the calculation of the soil loss coefficient used in the subsequent calculations to assess soil ingestion intake by grazing animals, and Table 4-2-3 presents the calculation of the soil loss coefficient used in the subsequent calculations to assess plant concentrations from root uptake. As discussed in Section 3.4.3, the soil loss coefficient due to leaching was calculated based on the following equation:

$$k_{sl} = \frac{P + I - E_v}{\theta * Z * (1 + (BD * K_d / \theta))}$$

where

k_{sl} = soil loss coefficient due to leaching (1/yr)

P = average annual precipitation (142.24 cm/yr)

I = average annual irrigation (0 cm/yr)

E_v = average annual evapo-transpiration (115.57 cm/yr)

θ = soil volumetric water content (0.0821 mL/cm³)

Z = soil depth (1 cm for ingestion and 20 cm for root uptake)

BD = bulk density of soil (1.5 g/cm³)

K_d = soil-water partition coefficient (mL/g)

See Section 3.4.3 for a complete discussion of the default values.

Soil concentrations for the individual metals were calculated using the loss coefficients in Tables 3-4-3 and 4-2-3 using the following equation:

Table 1. Calculation of the Soil Loss Coefficient for z=20 cm (root uptake ratio)

P (Ave. annual precip. cm/yr)	I (Ave. annual irrigation, cm/yr)	Ev (Ave. annual evapo- transpiration, cm/yr)	θ (Soil volumetric water content, ml/cm ³)	Z (Soil depth, cm)	BD (Bulk density) (g/cm ³)	K _d * (ml/g)	K _{el} (Soil loss due to leaching)	K _{egv} (Soil loss deg & vol)	K _{se} (Soil loss all processes) (/year)	Constituent
142.24	0	115.57	0.0821	20	1.5	1500	5.93E-04	0	5.93E-04	Al
142.24	0	115.57	0.0821	20	1.5	60	1.48E-02	0	1.48E-02	Ba
142.24	0	115.57	0.0821	20	1.5	650	1.37E-03	0	1.37E-03	Be
142.24	0	115.57	0.0821	20	1.5	850	1.05E-03	0	1.05E-03	Cr
142.24	0	115.57	0.0821	20	1.5	35	2.54E-02	0	2.54E-02	Cu
142.24	0	115.57	0.0821	20	1.5	10	8.89E-02	0	8.89E-02	Hg
142.24	0	115.57	0.0821	20	1.5	150	5.91E-03	0	5.91E-03	Ni
142.24	0	115.57	0.0821	20	1.5	900	9.88E-04	0	9.88E-04	Pb
142.24	0	115.57	0.0821	20	1.5	45	1.98E-02	0	1.98E-02	Sb
142.24	0	115.57	0.0821	20	1.5	300	2.96E-03	0	2.96E-03	Se
142.24	0	115.57	0.0821	20	1.5	40	2.22E-02	0	2.22E-02	Zn

*For inorganic compounds, K_d values were found in Bars et al., A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture. Prepared for US Dept. Of Energy, ORNL-5786, September 1984

**Precipitation and Evaporation data are based on average values for Alexandria, Louisiana and Lake, Louisiana.

$$S_c = \frac{(\text{Dep}_{\text{dry}} + \text{Dep}_{\text{wet}}) * (1 - e^{-(k_{sl} * T_c)}) * 100}{Z * BD * k_{sl}}$$

where

S_c	=soil concentration of pollutant after total time period of deposition ($\mu\text{g pollutant/g soil}$)
T_c	=total time period over which deposition occurs (30 yr)
Z	=soil depth (1 cm for ingestion and 20 cm for root uptake)
BD	=bulk density of soil (1.5 g/cm^3)
k_{sl}	=soil loss coefficient due to leaching ($1/\text{yr}$)
Dep_{wet}	=wet annual maximum unit deposition rate ($\text{g/m}^2\text{-yr}$)
Dep_{dry}	=dry annual maximum unit deposition rate ($\text{g/m}^2\text{-yr}$)

The calculation of the soil concentrations for direct ingestion and root uptake used the values for k_{sl} calculated with $Z=1 \text{ cm}$ and $Z=20 \text{ cm}$, respectively. Soil concentrations for direct ingestion by grazing animals are presented in Table 3-4-4, and soil concentrations for root uptake are presented in Table 4-2-4.

4.2.6

Total Concentration of Pollutants in Plants

Pollutants can be bioaccumulated in plants by three mechanisms: uptake by roots, direct deposition on exposed plant tissues and air-to-plant transfer of vapor phase pollutants. The total concentrations in leafy vegetables, fruits, and forage are presented in Tables 4-2-7 and 4-2-8. Total plant concentrations were calculated using the following equations from the Indirect Exposure Document (1990) and its Addendum (1993):

$$P_{\text{tot}} = P_r + P_d + P_v$$

$$P_r = S_c * B_r$$

$$P_d = 1000 * \text{Dep}_{\text{max}} / Y_p$$

$$P_v = B_{vpa} * \text{Conc}_{\text{envap}} * V_{Gag} / (D_a * 1000)$$

where

P_{tot}	=total plant concentration ($\mu\text{g cpd/g plant}$)
P_r	=partial plant concn. due to root uptake ($\mu\text{g cpd/g plant}$)
P_d	=partial plant concn. due to deposition ($\mu\text{g cpd/g plant}$)

Table 4-2-4. Soil Concentration for Root Uptake During Growth of Plants

Constituent	Tc, Total time period for deposition, yrs	Scind, Soil conc for root uptake forage, $\mu\text{g/g}$
Al	30	4.01E+02
Ba	30	2.62E+01
Be	30	5.29E-02
Cr	30	3.72E-02
Cu	30	3.78E+00
Hg	30	0.00E+00
Ni	30	5.44E+00
Pb	30	4.95E+01
Sb	30	4.07E+00
Se	30	1.55E+02
Zn	30	3.94E+00

*A total time period for deposition of 30 years was selected based on the discussions in USEPA, Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions, EPA/600/6-90/003 and USEPA, Addendum: Methodology for Assessing Health Risks Associated with Indirect Exposure to Combustor Emissions.

Table 4-2-5
Calculation of air-to-leaf biotransfer factor for mercury

Chemical	Kow octanol-water partition coefficient	H Henry's Law Constant (atm-m3/mol)	R ideal gas constant (atm-m3/mol-K)	T temperature (K)	Bvpa • air-to-leaf biotransfer factor
Hg	2.13E+01	1.10E-02	A	299.5	5.74E-04

A Note: Kow for mercury was estimated from Kp for mercury compounds. See USEPA, Dermal Exposure

Assessment: Principles and Applications, EPA/600/8-91/011B.

- Bvpa for all chemicals was calculated using Eq. 15-5b, as recommended in the Addendum to IED.

Table 4-2-6. Contribution of above ground concentration due to vapor-phase absorption or airborne contaminants

Chemical	Plant Food	Bypa air-to-leaf biotransfer factor	Cva vapor-phase concn. of contaminant in air (µg/m3)	Da density of air (kg/m3)	VGag Δ empirical correction factor	Cvpa dry weight concentration due to vapor-phase absorption or airborn contaminants (mg/kg)
Hg	leafy vegetable	5.74E-04	3.22E-01	1.19	1	1.55E-07
	fruit	5.74E-04	3.22E-01	1.19	0.05	7.76E-09
	general	5.74E-04	3.22E-01	1.19	0.01	1.55E-09

Δ The type of vegetation and preparation (cleaning, washing, peeling, etc.) must be considered for the determination of VGag. For this assessment, 1.0, 0.05, and 0.01 were chosen for leafy vegetables, fruit, and general above ground fruit and vegetables, respectively. These values were chosen based on the discussion in "Estimating Exposure to Dioxin-Like Compounds," EPA/600/6-88/005B. For this study, the general plant food group includes forage plants.

Table 4-2-7. Estimation of total concentration of pollutants in fruits and leafy vegetables

Constituent	Plant Food Group	Br Plant-Soil BCF µg cmpd/g plant/ µg cmpd/g soil	Pr Partial Plant Conc due to root uptake µg cmpd/g plant	Yp Yield (biomass) of edible portion of plant kg/m ²	Pd Partial Plant Conc due to deposition µg cmpd/g plant	Pv Partial Plant Conc Vapor abs µg cmpd/g plant	P Total Plant Conc µg cmpd/g plant
Al	leafy Veg Fruit	4.00E-03 6.50E-04	1.61E+00 2.61E-01	1.80E-01 9.00E-02	2.50E+02 9.48E+01	0.00E+00 0.00E+00	2.57E+02 9.50E+01
Ba	leafy Veg Fruit	1.50E-01 1.50E-02	3.92E+00 3.92E-01	1.80E-01 9.00E-02	2.00E+01 7.58E+00	0.00E+00 0.00E+00	2.39E+01 7.97E+00
Be	leafy Veg Fruit	1.00E-02 1.50E-03	5.29E-01 7.94E-05	1.80E-01 9.00E-02	3.33E-02 1.26E-02	0.00E+00 0.00E+00	3.38E-02 1.27E-02
Cr	leafy Veg Fruit	7.50E-03 4.50E-03	2.29E-01 1.67E-01	1.80E-01 9.00E-02	2.33E-02 8.81E-03	0.00E+00 0.00E+00	2.36E-02 9.01E-03
Cu	leafy Veg Fruit	4.00E-01 2.50E-01	1.51E+00 9.45E-01	1.80E-01 9.00E-02	3.33E+00 1.26E+00	0.00E+00 0.00E+00	4.84E+00 2.71E+00
Hg	leafy Veg Fruit	5.00E-01 2.00E-01	0.00E+00 0.08E+00	1.80E-01 9.00E-02	0.00E+00 0.00E+00	1.55E-07 7.76E-09	1.55E-07 7.76E-09
Ni	leafy Veg Fruit	6.00E-02 6.00E-02	3.26E-01 3.26E-01	1.80E-01 9.00E-02	3.67E+00 1.39E+00	0.00E+00 0.00E+00	3.99E+00 1.72E+00
Pb	leafy Veg Fruit	4.30E-02 9.00E-03	2.13E+00 4.45E-01	1.80E-01 9.00E-02	3.10E+01 1.17E+01	0.00E+00 0.00E+00	3.31E+01 1.22E+01
Sb	leafy Veg Fruit	2.00E-01 3.00E-02	8.15E-01 1.22E-01	1.80E-01 9.00E-02	3.33E+00 1.26E+00	0.00E+00 0.00E+00	4.15E+00 1.39E+00
Se	leafy Veg Fruit	2.50E-02 2.50E-02	3.87E+00 3.87E+00	1.80E-01 9.00E-02	1.00E+02 3.79E+01	0.00E+00 0.00E+00	1.04E+02 4.18E+01
Zn	leafy Veg Fruit	1.50E+00 9.00E-01	5.91E+00 3.55E+00	1.80E-01 9.00E-02	3.33E+00 1.26E+00	0.00E+00 0.00E+00	9.24E+00 4.81E+00

Notes:
Values for Yp were found in the Indirect Exposure Document as listed in Belcher and Travis, 1989
Values for Br were taken from Bates et al., 1984.

Table 4--8. Estimation of Total Concentration of Pollutants in Forage

Constituent	Pv	Bf	Fr	Yf	Fd	F
Plant Food Group	Partial Plant Conc. Vapor abs µg cpd/g plant	Plant-Soil BCF µg cmpd/g plant/ µg cmpd/g soil	Partial Plant Conc due to root uptake µg cmpd/g plant	Yield (biomass) of edible portion of forage kg/m ²	Partial Plant Conc due to deposition µg cmpd/g plant	Total Conc in Forage µg cmpd/g plant
Al	Forage 0.00E+00	0.004	1.61E+00	0.3100	3.88E+02	3.89E+02
Ba	Forage 0.00E+00	0.15	3.92E+00	0.3100	3.10E+01	3.49E+01
Be	Forage 0.00E+00	0.01	5.29E-04	0.3100	5.17E-02	5.22E-02
Cr	Forage 0.00E+00	0.0075	2.79E-01	0.3100	3.62E-02	3.65E-02
Cu	Forage 0.00E+00	0.4	1.51E+00	0.3100	5.17E+00	6.68E+00
Hg	Forage 1.55E-09	0.5	0.00E+00	0.3100	0.00E+00	1.55E-09
Ni	Forage 0.00E+00	0.06	3.26E-01	0.3100	5.69E+00	6.01E+00
Pb	Forage 0.00E+00	0.043	2.13E+00	0.3100	4.81E+01	5.02E+01
Sb	Forage 0.00E+00	0.2	8.15E-01	0.3100	5.17E+00	5.99E+00
Se	Forage 0.00E+00	0.025	3.87E+00	0.3100	1.55E+02	1.59E+02
Zn	Forage 0.00E+00	1.5	5.91E+00	0.3100	5.17E+00	1.11E+01

*Values for Bf and Yf were taken from Baes et al., 1984.

P_v	=partial plant concn. due to vapor absorption ($\mu\text{g cpd/g plant}$)
S_c	=soil concentration ($\mu\text{g/g}$)
B_r	=plant-soil biotransfer factor ($(\mu\text{g cpd/g plant}) / (\mu\text{g cpd/g soil})$)
Dep_{max}	=maximum cumulative deposition on edible portion of plant (g/m^2)
Y_p	=yield of edible portion of plant (kg/m^2)
B_{vpa}	=air-plant biotransfer factor
$Conc_{envap}$	=vapor unit concentration ($\mu\text{g/m}^3$)
VG_{ag}	=empirical correction factor
D_a	=density of air (kg/m^3)

Biotransfer factors from Baes et al. (1984) and soil concentrations for root uptake (derived using a soil depth of 20 cm) were used to calculate the partial plant concentration due to root uptake.

The maximum cumulative deposition onto the edible portions of the plant (Tables 4-2-1 and 4-2-2) and default yield values listed in the Indirect Exposure Document were used to calculate the partial plant concentration due to direct deposition.

Only mercury has a vapor absorption contribution to total plant concentration. The biotransfer factor for mercury was calculated using Equation 5-15b from the Addendum (1993); this calculation is shown in Table 4-2-5. To calculate the vapor-phase contribution, empirical correction factors of 1, 0.05, and 0.01 were chosen for leafy vegetables, fruit, and forage, respectively. These values were selected based on discussions in "Estimating Exposure to Dioxin-Like Compounds," EPA/600/6-88/005B. Calculation of the concentration due to vapor phase absorption of mercury is shown in Table 4-2-6.

4.2.7 *Exposure Pathways*

An exposure pathway consists of four necessary elements:

- chemicals of concern and mechanism of chemical release to the environment;
- an environmental transport medium (e.g. water, air, soil);
- a point of potential wildlife contact with the contaminated medium; and,

- a wildlife exposure route at the point of contact (e.g. inhalation, ingestion, dermal).

The primary exposure pathways for the contaminants of concern are influenced by the physio-chemical properties of the compounds. These factors interact to define the various routes by which the chemicals originating at the property could affect potentially exposed populations.

The primary exposure pathways identified in this assessment are the ingestion of soils and plant material for the invertebrate and large mammal species; and the ingestion of soil, plant and prey by the bird and small mammal. Other exposure routes such as inhalation, dermal absorption and water ingestion were not considered.

4.2.8 *Receptor Characterization*

4.2.8.1 *Determination of Potential Receptors*

Identification of wildlife receptors that might be affected by the presence of substances in toxic amounts is an important factor in the evaluation of ecological impacts.

Section 4.1 lists and describes a variety of animals and plants that potentially occur on the 700 acre property and surrounding region. The majority of these species come in contact with the soils of the property. Soil contamination could potentially lead to exposure of the animals (invertebrates and vertebrates) and plants residing within the property. The main exposure route of contaminated soils to animals would be the direct ingestion of soils. Not all animals will be exposed in this manner. Plants may accumulate metals within their leafy tissue, stems, or roots. There are three exposure routes for plants which include: direct adsorption from the soil; direct contact and adherence of contaminated particulate; and, the adsorption of vapor into aerial plant parts. Contaminated vegetation poses another route of exposure for animals that feed on vegetation.

Wildlife most likely to be abundant and occur as year-round residents of the pine-hardwood forests of the property and the surrounding area were determined based on amphibian and reptile, bird, and mammal studies conducted within the Catahoula Ranger District. Table 4-2-9 lists the most abundant wildlife species likely to occur within the pine-hardwood forest. Abundant bird species were based on species that were observed more than 50 times during the study and occur as year-round residents. Abundant amphibians, reptiles, and mammals were based on the species that were observed most often during the studies.

Table 4-2-9 *List of the Most Abundant Wildlife Associated with the Pine-Hardwood Forest*

Wildlife Species	Wildlife Species
<u>Amphibians</u>	<u>Reptiles</u>
Woodhouse's toad	Green anole
Eastern narrowmouth toad	Eastern fence lizard
Southern leopard frog	Ground skink
<u>Mammals</u>	<u>Birds</u>
Eastern pipistrelle	Northern cardinal
Eastern red bat	Blue jay
Short-tailed shrew	Carolina wren
Nine-banded armadillo	Tufted titmouse
Eastern cottontail	Pine warbler
Swamp rabbit	Carolina chickadee
Eastern gray squirrel	Red-bellied woodpecker
Eastern fox squirrel	American crow
Cotton mouse	Northern bobwhite
Golden mouse	Pileated woodpecker
Coyote	Northern flicker
Common gray fox	American robin
Common raccoon	Mourning dove
White-tailed deer	Brown thrasher
	Brown-headed nuthatch
	Brown-headed cowbird

In an effort to determine the ecological risk from potentially contaminated soil, indicator species representing the worst-case receptors were selected and served as the basis for the exposure calculations. The indicator species selected include the earthworm (*Lumbricus terrestris*), American robin (*Turdus migratorius*), the cotton mouse (*Peromyscus gossypinus*), and the white-tailed deer (*Odocoileus virginianus*). The rationale for the selection of these species is presented below.

Earthworms are common soil invertebrates, and *L. terrestris* is an abundant widespread species. *L. terrestris* lives in the soil. It is a nocturnal species feeding in the surface organic litter layer after dark. It consumes plant material, up to 120 mg of plant litter per gram of body weight (Edwards and Lofty, 1972). Earthworms will also ingest soil directly, and 20-30 percent of its daily intake is due to ingested soil (Edwards and Lofty, 1972). The body weight of *L. terrestris* averages 1.5 grams (Edwards and Lofty, 1972). *L. terrestris* can live up to 6 years in a protected culture but usually lives no more than a few months in its natural environment (Edwards and Lofty, 1972).

Earthworms would be exposed to contaminants of concern by direct ingestion of plant, soil and water. In addition, soluble contaminants may be absorbed to some degree through its skin. Earthworms are the prey of many species of wildlife such as numerous species of birds and small mammals. Earthworms are expected to occur on the property and surrounding area, however, natural soil conditions would limit populations. Area soils are fine sandy loams with soil pH's ranging from 4.5 to 5.2 (Kilpatrick et al., 1986). Earthworms are most abundant in organic soils. On acid peaty soils with pH values of 4.0 - 5.5, earthworms populations were 100-200 pounds per acre, in basic soils (pH 6.5 - 7.5) populations range from 500 - 3,000 pounds per acre (Lewis and Taylor, 1976).

A large amount of leaf litter can be expected within a forest during the fall. It has been calculated that earthworms can consume 3 tons of leaf litter per hectare within a 3 month period (Edwards and Lofty, 1972).

The American robin (*Turdus migratorius*) is one of the most numerous and widely distributed songbirds within eastern North America (Bull, 1964). The robin is generally considered a migrant bird within the northern states; however, within Louisiana the robin resides year-round (Peterson, 1980). The robin's diet consists of 60 percent fruits and berries and 40 percent animal food. Fruits and berries consists of red cedar, greenbrier, mulberry, pokeweed, juneberry, blackberry, raspberry, wild cherry, sumac, woodbine, wild grape, dogwood, and blueberry. Animal food

consists mostly of beetles and caterpillars but bugs, hymenoptera, flies, grasshoppers, spiders, earthworms, millipedes, sowbugs, and snails are also eaten by the robin (Bent, 1949). No data was available on the daily intake of robins, therefore, the daily intake of 11 grams for a mourning dove was used. It was estimated that the robin would ingest 0.5 percent of its total diet as soil. The body weight of an adult robin is 84 grams (Terres, 1980). The maximum life span of a robin is 12 years and 6 months (Altman and Dittmer, 1972). Robins would be exposed to contaminants of concern by direct ingestion of soil invertebrates, vegetation (fruits and berries), soil, and water.

The cotton mouse (*Peromyscus gossypinus*) typically inhabits moist, timbered areas, especially swamps and wet river bottoms but also inhabits brushland, rocky areas, and beaches. The cotton mouse is a nocturnal rodent nesting on sandy ridges along bayous and streams, and in or under logs or palmetto scrub. The cotton mouse is omnivorous eating a variety of plant and animals reflecting the local availability of foods at various seasons. The animals consumed by the cotton mouse include invertebrates such as insects, snails, earthworms, spiders, centipedes, and millipedes. Plant food includes nuts, wild seeds, domestic grains, fruits and fruit pits, and some leafy vegetation (Schwartz and Schwartz, 1959). For the purpose of this screening assessment, it is assumed that food availability is equal in all seasons, therefore, the mouse would ingest an equal amount of plant and animal food. The daily food consumption for a mouse is approximately 13 percent of its body weight per day (USEPA, 1986) and soil consumption is equal to 2 percent of its daily diet. The approximate body weight of a cotton mouse is 30 grams (Whitaker, 1980). Mice would be exposed to contaminants of concern by direct ingestion of soil invertebrates, vegetation (nuts and seeds), soil, and water.

White-tailed deer (*Odocoileus virginianus*) occur in a variety of habitats including conifer forests, deciduous forests, bottomland hardwoods, farmland, and brushy areas but tend to utilize the borders and edges more than dense uniform stands of trees. Deer are primarily nocturnal but may be active anytime during the day. They are herbivores and browse chiefly on leaves, twigs and buds, fruits of trees (acorns and beechnuts) and shrubs, foliage of herbaceous plants, and cultivated crops (Schwartz and Schwartz, 1959). The home range of deer seldom exceeds 300 acres where food, water, and cover are interspersed (USDA FS, 1986). Deer ingest approximately 2.26 Kg of natural food daily (Forbes et al., 1971). Approximately 6 percent of the deer's daily food consumption is soil which has adhered to vegetative roots or incidentally ingested from grazing on acorns and nuts (Baes et al., 1984). Deer may live up to 25 years in captivity, however, the average age of deer living in the wild is 2.5 years due mainly to hunting pressure (Schwartz and Schwartz, 1959; Forbes et al., 1971). It was assumed that a deer of 2.5 years old would

weigh approximately 30 Kg. Deer would be exposed to contaminants of concern by direct ingestion of soil, vegetation (fruits, leaves, twigs), and water.

Table 4-2-10 summarizes the physical and ecological parameters used to calculate exposures for each of the indicator species.

4.2.9 *Potential Wildlife Contact With the Contaminants of Concern*

The property and surrounding area consists of similar wildlife habitat and vegetative composition. It is therefore assumed that wildlife densities will be equal from one area to the next. According to the modelling results for deposition rates, there is no prevailing wind within the area of the proposed burn facility, therefore, deposition rates of airborne particulates occur within concentric circles around the facility with the highest concentrations being the closest and the lowest concentrations being further away from the facility. It was concluded that wildlife inhabiting the property or surrounding area (within the deposition area) has the potential to come in contact with contaminants of concern no matter what direction it occurs from the facility.

4.2.9.1 *Wildlife Exposure Routes*

Three major exposure routes for contaminants of concern to wildlife have been identified. These routes of exposure include:

- ingestion of contaminated soil
- ingestion of contaminated vegetation
- ingestion of prey

In addition to the above exposure routes, ingestion and absorption of water would serve as an exposure route to wildlife and aquatic life, however, these pathways were not assessed due to the lack of permanent surface water within the property and the immediate surrounding area. Direct absorption through the skin and inhalation were also not considered.

4.3 *ECOLOGICAL EFFECTS ASSESSMENT*

4.3.1 *Toxicity Assessment*

Available toxicity data for each of the contaminants of concern for the identified indicator species is presented in Table 4-3-1. The selection of toxicity indices was based on a hierarchy of preferred data. Where

Table 4-2-10 Indicator Species Physical and Ecological Parameters Used for Exposure Calculations

Characteristics	Earthworm	Robin	Mouse	Deer
Body Weight (BW)	1.5 g	84 g	30 g	30 Kg
Feeding habits	Plant material and soil	Omnivore	Omnivore	Herbivore
Total Food Intake	120 mg/g-BW or 0.18 g/day	11 g/day	13% of BW or 3.9 g/day	2.26 Kg/day
Ingestion of Vegetation	70% daily intake or 1.26E-01 g/day	60% daily intake or 6.6E-03 Kg/day	50% daily intake or 1.95E-03 Kg/day	2.26E-00 Kg/day
Ingestion of Prey	0	40% daily intake or 4.4E-03 Kg/day	50% daily intake or 1.95E-03 Kg/day	0
Ingestion of Soil	30% daily intake or 5.4E-02 g/day	0.5% daily intake or 5.4E-15 Kg/day	2% daily intake or 7.8E-05 Kg/day	6% daily intake or 1.36E-01 Kg/day

Table 4-3-1 Comparison of Toxicity Values with Total Dose of Contaminants Ingested

Indicator Species	Contam. of Concern	CHRONIC		ACUTE		Comments and		Comments and		Tested Species
		Total Dose Ingested per Body Wt. (mg/Kg/day)	Ingested per Body Wt. (mg/Kg/day)	Total Dose Ingested per Body Wt. (mg/Kg/day)	NOAEL (mg/Kg/day)	Reference for NOAEL Value	Chronic Hazard Quotient (mg/Kg/day)	LD50 (mg/Kg/day)	Reference for LOAEL Value	Other Toxicity Data (mg/Kg)
Earthworm	Aluminum	7.50E+01	7.50E+01	7.50E+01						No Data
Robin	Aluminum	4.73E+00	9.46E+00	9.46E+00						No Data
Mouse	Aluminum	8.71E+00	1.16E+01	1.16E+01	1.90E+01	a	4.58E-01	7.70E+02	c	1.51E-02
Deer	Aluminum	8.11E+00	1.62E+01	1.62E+01	1.40E+01	b	5.79E-01	2.61E+02	d	6.22E-02
Earthworm	Antimony	2.41E-01	2.41E-01	2.41E-01						No Data
Robin	Antimony	1.83E-02	3.67E-02	3.67E-02						No Data
Mouse	Antimony	3.16E-02	4.21E-02	4.21E-02	3.30E-01	e	9.02E-02			Mouse
Deer	Antimony	2.87E-02	5.74E-02	5.74E-02	2.62E-01	f	1.00E-01			Rat
Earthworm	Barium	3.19E+00	3.19E+00	3.19E+00						No Data
Robin	Barium	1.37E+00	2.74E+00	2.74E+00						No Data
Mouse	Barium	1.72E+00	2.29E+00	2.29E+00	9.30E-01	g	1.81E+00			Mouse
Deer	Barium	1.33E+00	2.66E+00	2.66E+00	5.40E-02	h	2.46E+01	2.90E+02	i	1.21E-02
Earthworm	Beryllium	1.55E-03	1.55E-03	1.55E-03						No Data
Robin	Beryllium	1.15E-04	2.29E-01	2.29E-01						No Data
Mouse	Beryllium	1.99E-04	2.65E-01	2.65E-01	9.30E-01	j	2.10E-01	1.80E+01	k	1.47E-05
Deer	Beryllium	1.82E-04	3.63E-01	3.63E-01	7.00E-01	j	2.59E-01	1.83E+01	l	1.98E-05
Earthworm	Chromium	3.49E-04	3.49E-04	3.49E-04						No Data
Robin	Chromium	2.43E-05	4.85E-05	4.85E-05	6.00E+01	m	4.04E-07			Chicken
Mouse	Chromium	4.31E-05	5.75E-05	5.75E-05	5.70E+01	n	7.56E-07			Mouse
Deer	Chromium	3.96E-05	7.93E-05	7.93E-05	9.80E+00	o	1.01E-06	1.83E+02	p	4.33E-07
Earthworm	Copper	8.16E-02	8.16E-02	8.16E-02						Earthworm
Robin	Copper	2.64E-02	5.28E-02	5.28E-02	2.90E+00	q	9.11E-03	1.50E+02	t	5.44E-04
Mouse	Copper	3.39E-02	4.53E-02	4.53E-02	2.03E+01	r	1.67E-03			Mallard Rat
Deer	Copper	2.68E-02	5.35E-02	5.35E-02	2.16E+01	s	1.24E-03			Cattle
Earthworm	Lead	3.15E+00	3.15E+00	3.15E+00						No Data
Robin	Lead	2.22E-01	4.44E-01	4.44E-01	8.90E+00	u	2.49E-02	3.20E+02	x	1.39E-03
Mouse	Lead	3.93E-01	5.23E-01	5.23E-01	1.90E+01	v	2.07E-02			Jap. Quail/Chicken
Deer	Lead	3.60E-01	7.21E-01	7.21E-01	9.00E-01	w	4.00E-01			Mouse Cattle

Table 4.3.1 Comparison of Toxicity Values with Total Dose of Contaminants Ingested (Cont'd)

Indicator Species	Contam. of Concern	CHRONIC		ACUTE		Comments and		Comments and		Other Toxicity Data (mg/Kg)	Acute Hazard Quotient	Tested Species
		Total Dose Ingested per Body Wt. (mg/Kg/day)	Ingested per Body Wt. (mg/Kg/day)	Total Dose Ingested per Body Wt. (mg/Kg/day)	NOAEL (mg/Kg/day)	Reference for NOAEL Value	Chronic Hazard Quotient	10%o (mg/Kg/day)	Reference for LOAEL Value			
Earthworm	Mercury	1.30E-09	1.30E-09	1.30E-09								No Data
Robin	Mercury	6.07E-10	1.21E-09	1.21E-09	3.20E-02	y	1.90E-08					Jap. quail
Mouse	Mercury	7.56E-10	1.01E-09	1.01E-09	6.00E-01	z	1.76E-09					Mouse
Deer	Mercury	5.84E-10	1.17E-09	1.17E-09	2.30E-01	aa	2.54E-09	2.50E+01	bb		4.51E-11	Rat
Earthworm	Nickel	3.18E-02	3.18E-02	3.18E-02								No Data
Robin	Nickel	4.68E-03	9.36E-03	9.36E-03	1.80E+01	cc	2.60E-01					Chicken
Mouse	Nickel	6.77E-03	9.02E-03	9.02E-03	4.40E+01	dd	1.54E-01	1.36E+02	ff		6.63E-05	Mouse
Deer	Nickel	5.69E-03	1.14E-02	1.14E-02	7.00E-01	ee	8.13E-01	6.60E+01	gg		1.72E-01	Rat
Earthworm	Selenium	2.32E+00	2.32E+00	2.32E+00								No Data
Robin	Selenium	6.32E-01	1.26E+00	1.26E+00	5.00E-01	hh	1.26E+00					Mallard
Mouse	Selenium	8.28E-01	1.10E+00	1.10E+00	3.40E-01	ii	2.44E+00	3.20E+00	kk		3.45E-01	Mouse
Deer	Selenium	6.61E-01	1.32E+00	1.32E+00	3.00E-01	jj	2.20E+00	4.80E+00	kk		2.75E-01	Rat
Earthworm	Zinc	1.57E-01	5.15E-02	5.15E-02						662 (pp)		Earthworm
Earthworm	Zinc	1.57E-01	5.15E-02	5.15E-02						1100 (pp)		Earthworm
Robin	Zinc	2.58E-02	4.86E-02	4.86E-02	5.59E+00	ll	4.61E-03			2000 (tr)		Jap quail
Mouse	Zinc	3.65E-02	6.07E-02	6.07E-02	7.69E+01	mm	4.74E-04	8.60E+01	oo		7.06E-04	Mouse
Deer	Zinc	3.03E-02	0.00E+00	0.00E+00	6.40E+01	nn	4.74E-04					Cattle

Comments and References:

- NOAEL for systemic and reproductive effects from chronic exposure. (Ondreicks et al., 1966)
- NOAEL for neurological effects from intermediate exposure. (Thorne, et al., 1987)
- (Ondreicks et al., 1966)
- NOAEL for systemic effects from chronic exposure. (Ondreicks et al., 1966)
- NOAEL for systemic effects from chronic exposure. (Schroeder, et al., 1968)
- NOAEL for systemic effects from chronic exposure. (Schroeder, et al., 1970)
- NOAEL for systemic effects from chronic exposure. (Schroeder & Mitchener, 1975)
- NOAEL for systemic effects from chronic exposure. (Perry, et al., 1985)
- (Tardiff, et al., 1980)
- NOAEL for systemic effects from chronic exposure. (Schroeder & Mitchener, 1975)
- (Kimmerle, 1966)
- (Venugopal and Luckey, 1977)
- Feed concentration of 1000 mg Cr III/Kg had no adverse effect (NAS, 1980). NOAEL was calculated assuming adult chickens consume 0.3905 Kg/day and have a body weight of 6.5 Kg (USEPA, 1988).

Table 4-3-1 Comparison of Toxicity Values with Total Dose of Contaminants Ingested (Cont)

Comments and References (Cont):

- (n) NOAEL for systemic effects from intermediate exposure of Cr VI. (Trivedi et al., 1989)
- (o) NOAEL for systemic effects from intermediate exposure of Cr VI. (Diaz Mayans, et al., 1986)
- (p) LD50 for Cr III (Vernot, et al., 1977)
- (q) The daily intake of 29 mg Cu/Kg was tolerated by mallards so it was converted to a NOAEL by dividing by a factor of 10. (Demayo et al., 1982)
- (r) Feed concentration of 500 mg/Kg had no adverse effect (Boyd et al., 1938) NOAEL was calculated assuming adult rats consume 0.024 Kg/day and have a body weight of 0.59 Kg (USEPA, 1988).
- (s) Feed concentration of 900 mg/Kg had no adverse effect (Felsman et al., 1973). NOAEL was calculated assuming cattle consume 9.04 Kg/day and have a body weight of 376 Kg (USEPA, 1988).
- (t) Soil concentration of 150 mg/Kg killed 50% of the earthworm population. (Ma, 1984)
- (u) Feed concentration of 100 mg/Kg had no adverse effect (Morgan et al., 1975) NOAEL was calculated assuming quail consume 0.0152 Kg/day and have a body weight of 0.17 Kg (USEPA, 1986).
- (v) NOAEL for reproductive effects from intermediate exposure. (Donald et al., 1986)
- (w) NOAEL for systemic effects from chronic exposure (Azar, et al., 1973)
- (x) Daily intake of 320 mg/Kg killed 50% of the chicken population. (Vengris and Mare, 1974)
- (y) The LOAEL of 0.32 mg/lb/Kg was converted to a NOAEL by dividing by a factor of 10. (Hill and Soares, 1984)
- (z) NOAEL for immunological effects from intermediate exposure. (Deiter et al., 1983)
- (aa) NOAEL for systemic effects from intermediate exposure. (NTI, 1991)
- (bb) (Kostial et al., 1978)
- (cc) Feed concentration of <300 mg/Kg nickel had no adverse effect (USEPA, 1983). NOAEL was calculated assuming adult chickens consume 0.3905 Kg/day and have a body weight of 6.5 Kg (USEPA, 1988).
- (dd) NOAEL for systemic effects from intermediate exposure. (Deiter et al., 1988)
- (ee) NOAEL for systemic effects from intermediate exposure. (Weischer, et al., 1980)
- (ff) (Haro, et al., 1968)
- (gg) (Mastromatteo, 1986)
- (hh) Feed concentration of 10 mg/Kg had no adverse effect on reproduction (Petelke, 1991). NOAEL was calculated assuming mallards consume 5% of their body weight (1.2 Kg) (Murphy, 1992; Boyer & Gooders, 1990)
- (ii) NOAEL for reproductive effects from intermediate exposure. (Nobunaga, et al., 1979)
- (jj) NOAEL for death from chronic exposure. (Tinsley, et al., 1967)
- (kk) (Petrukova, 1970)
- (ll) Feed concentration of 62.7 mg/Kg had no adverse effect (Hamilton, et al., 1979). NOAEL was calculated assuming quail consume 0.0152 Kg/day and have a body weight of 0.17 Kg (USEPA, 1986).
- (mm) NOAEL for immunological effects from intermediate exposure. (Schiffer, et al., 1991)
- (nn) NOAEL for systemic effects from intermediate exposure. (Jenkins and Iridoglou, 1991)
- (oo) (Domingo et al., 1988)
- (pp) Soil concentration of 662 mg/Kg killed 50% of the earthworm population (Eisler, 1993)
- (qq) Soil concentration of 1100 mg/Kg was reported as toxic to earthworms (Beyer, 1982)
- (rr) Feed concentration of 2000 mg/Kg (179 mg/Kg/day, based on 0.17 Kg BW and 0.0152 daily intake) decreased growth, hemoglobin, hematocrit plus mortality (Hamilton, et al., 1979)

available, NOAEL's (No Observable Adverse Effect Levels) were used to define acceptable doses. In the absence of NOAEL's, LOAEL's (Lowest Observable Adverse Effect Levels) were used by converting them to approximate NOAEL's by dividing by a factor of 10. Lethal dose (LD₅₀) data, where available, was also presented in Table 4-3-1. The preferred order (from most to least) for comparison to the calculated doses was NOAEL's, LOAEL's, and LD₅₀'s. Appendix 2 presents detailed toxicological profiles for each of the contaminants of concern.

4.3.2 *Summary of Literature Toxicity Effects for the Contaminants of Concern*

The direct comparison of calculated soil concentrations to literature toxicity values is not practical nor possible since most toxicity studies were conducted with laboratory test mammals for the purpose of defining harm to humans. Only a very limited number of specific studies have been conducted to determine the effects of contaminated soils to wildlife. A summary of the toxicological effects of the contaminants of concern to wildlife is presented in the following sections.

4.3.2.1 *Aluminum*

Aluminum is only acutely toxic to laboratory animals at very high doses. Because most long-term animal toxicity studies have not identified adverse effects (ATSDR, 1990), the determination of an adequate No Observed Adverse Effect Level (NOAEL) in laboratory species is not possible. Available data indicates that ingested aluminum has no effect on reproductive function, however, the results of studies on the effect of aluminum toxicity to development are contradictory (ATSDR, 1990). There was no available data for terrestrial animal bioconcentration factors for aluminum.

4.3.2.2 *Antimony*

The toxicological effects of antimony are numerous, and include pulmonary fibrosis, altered EKG readings, myocardial damage, vomiting and diarrhea in dogs, liver and kidney degeneration, and muscle weakness (ATSDR, 1990a). The results of subchronic studies (ATSDR, 1990a) do not adequately define a NOAEL or LOAEL for these effects. The severity of antimony toxicity occurs in the following order (most severe to least): organic antimony, metallic antimony, inorganic trivalent antimony (Bradley and Frederick, 1941).

4.3.2.3 *Barium*

Barium is poorly absorbed in adult animals, but may be more readily absorbed in juveniles (Taylor et al., 1962). Chronic exposure of barium

primarily affects the cardiovascular system. Cardiovascular effects include increased blood pressure, changes in heart rhythm, myocardial damage, and changes in heart physiology and metabolism (ATSDR, 1990b). Barium salts are not considered acutely toxic, since LD₅₀ data is consistently greater than 100 mg/Kg (ATSDR, 1990b).

4.3.2.4 *Beryllium*

Beryllium is poorly absorbed in experimental animals when orally administered (ATSDR, 1993). The extent of absorption was less than 5 percent in several studies with mice, dogs, rats, and monkeys (LeFevre and Joel, 1986). Soluble beryllium fluoride was determined to be 10 times more toxic than beryllium sulfate or chloride when assessed using oral LD₅₀ values (ATSDR, 1993). Limited subchronic and chronic studies exist for beryllium toxicity (ATSDR, 1993).

4.3.2.5 *Chromium*

Most hexavalent chromium (Cr VI) is metabolically reduced to trivalent chromium (Cr III) in the acidic environment of the stomach (Donaldson and Barreras (1966). The absorption of either form of chromium is less than 1.5 percent of the dose, as determined in rat studies (Sayato et al., 1980; Henderson et al., 1979). In animals, Cr III is less toxic than Cr VI. Plants do not appear to accumulate chromium in above ground parts, and therefore, animals apparently absorb little chromium from plants in their digestive tract (USFWS, 1978).

4.3.2.6 *Copper*

Adequate quantitative data regarding the absorption of copper after oral intake in animals is limited. The cupric (2+) form of copper likely determines the bioavailability and toxicity of this metal. Homeostasis is maintained by gastrointestinal feedback processes that prevent the absorption of excessive copper (ATSDR, 1990c), therefore, the systemic toxicity of orally administered copper is low. Neurological toxicity is not considered an important concern at environmentally relevant intake concentrations.

4.3.2.7 *Lead*

The ability of lead to bind to subcellular structures such as the mitochondria allows it to virtually affect every system in the body (USEPA, 1986a). Tissue distribution is initially in the liver, lungs, and kidneys, followed by relocation and deposition in bone (Aungst et al., 1981; Kozlowski and Wojcik, 1987). The symptoms of lead poisoning

include flaccid paralysis, emaciation, anemia, lethargy, greenish diarrhea, impaction of proventriculus and inhibition of heme production.

4.3.2.8

Mercury

Oral absorption of inorganic mercury ranged from 38 percent in suckling mice to 1 percent in adult mice (Clarkson, 1971). Elemental mercury is highly lipophilic and distributes to most body tissues, especially the kidney (Hurch et al., 1976). The most susceptible life-stage to mercury toxicity is the developing organism of all species tested (Eisler, 1987). Organomercury compounds are generally more toxic than inorganic mercury compounds. Sublethal affects of mercury on birds included adverse effects on growth, development, reproduction, blood and tissue chemistry, metabolism, behavior, histopathology and bioaccumulation.

4.3.2.9

Nickel

Depending on the form and method of nickel administration, typical absorption values in rats and dogs ranged from 1 to 10 percent (USEPA, 1986b; ATSDR, 1993d). Soluble nickel salts (nickel acetate and nickel sulfate hexahydrate) are more toxic than insoluble salts (nickel oxide and nickel subsulfide) (USPHS, 1987d). Orally administered nickel distributes mainly to the kidneys, with little appearing in neural tissue, and placental transfer also occurs (USEPA, 1986b; ATSDR, 1993d). Trace amounts of nickel are essential for normal growth and reproduction in rats, chicks, cows and goats (ATSDR, 1993d).

4.3.2.10

Selenium

The absorption of all selenium compounds is virtually complete and dose independent (ATSDR, 1989). Selenium toxicity depends on its interaction with blood concentrations of other metals and in many cases, selenium can reduce the health hazard from other metals (Frost, 1972). Acute poisoning of livestock show abnormal movements, lowered head, diarrhea, elevated temperatures, labored breathing, abdominal pain, and dilated pupils. Chronically exposed laboratory animals show adverse effects of the cardiovascular, gastrointestinal, hematological, hepatic, dermal, immunological, neurological, and reproductive systems (ATSDR, 1989).

4.3.2.11

Zinc

Zinc is an essential trace element whose deficiency in animals is associated with developmental disorders (ATSDR, 1992a). Zinc is widely distributed in all tissues, where it is a cofactor in many enzymatic reactions. High oral doses of zinc cause gastrointestinal distress, diarrhea, and pancreatic

abnormalities in humans, cats, and sheep, but not dogs (Chobanian, 1981; Drinker et al., 1927; Allen et al., 1983). Doses associated with these gastrointestinal disorders are highly species-specific. Zinc absorption in laboratory animals is decreased in the presence of other elements such as calcium and phosphorous.

4.3.3

Exposure Calculation

A screening, semi-quantitative assessment of the risk of incidental exposure of wildlife to soils, vegetation and prey was conducted. The following equations were utilized to determine both the acute and chronic, worst-case total daily intake of the metals of concern:

$$DI = \frac{DOSE_{tot}}{BW}$$

$$DOSE_{tot} = \{CONCEN_{soil} * IR_{soil} + CONCEN_{veget} * IR_{veget} + CONCEN_{prey} * IR_{prey}\} * EF * ABS$$

where:

DI =Daily intake rate of contaminant of concern (mg/kg/day)

DOSE_{tot} =Total dose of metal ingested (mg/day)

BW =Body weight of indicator species (kg)

CONCEN_x =Concentration of metal in medium x (soil, vegetation, prey) (mg/kg)

IR_x =Ingestion rate of medium x (kg/day)

EF =Exposure frequency (Fraction of time spent on site)

ABS =Absorption fraction (Fraction bioavailable)

The total dose of contaminant ingested (DOSE_{tot}) is the sum of each of the pathway intakes appropriate for each indicator species. This sum is adjusted by the absorption fraction for each metal and the exposure frequency for the species. Body weights, total daily food intake, plant ingestion rates, soil ingestion rates, and prey ingestion rates for each of the indicator species are presented in Table 4-2-10.

Soil and vegetation concentrations were derived from the modeling described in Section 4.2. Prey concentrations were calculated based on the total dose to the prey using the following equation:

$$CONCEN_{prey} = DOSE_{tot} * BIO$$

where

CONCEN _{prey}	=Concentration of metal in prey (mg/kg)
DOSE _{tot}	=Total dose of metal ingested by prey (mg/day)
BIO	=Biotransfer factor (day/kg)

Due to limited data available, a biotransfer factor of 1 was selected for all species and all metals. This conservative approach assumes 100 percent biotransfer from soil and vegetation to the prey and 100 percent biotransfer from the prey to the carnivore.

Acute and chronic calculations for each of the indicator species are presented in 4-3-2a and 4-3-2b, respectively.

Acute exposure for each indicator species was calculated using an exposure frequency of 1. ERM assumed that each indicator species spent 100 percent of its time on-site for the short-term exposure scenario. For chronic exposure, exposure frequencies of 100, 50, 75, and 50 percent were selected for the earthworm, robin, mouse, and deer, respectively. Exposure frequencies were adjusted for the indicator species, with the exception of the earthworm, to account for migration and the extent of each species' home range. For example, on a long term basis, a deer would not realistically be exposed 100 percent of its time considering a deer's home range may be as large as 300 acres. The same rationale was used for the robin, and in addition, robins may migrate which may further lessen the birds' exposure. Thus, exposure frequencies were selected for the deer, robin, and mouse based on the fact that these species would not realistically spend their lifetime in one small area.

The absorption fraction indicates how well a chemical constituent will be absorbed and integrated into an organism's systems. General absorption rates for the metals were used, if available in the literature. The following percentage absorption rates were used: aluminum, 27; antimony, 7; beryllium, 5; chromium, 1.5; nickel, 1.9; and zinc, 5.7. Where absorption rates were not indicated for the remaining metals, 10 percent absorption was assumed. This conservative absorption value was chosen based on the fact that most of the metals will be emitted in the form of oxides (Dempsey and Oppelt, 1993). As listed in Perry's Chemical Engineers' Handbook, many oxides of the metals of interest are insoluble. For example, oxides of lead, nickel, and aluminum are insoluble; mercury and zinc oxides have solubilities on the order of 10^{-3} to 10^{-4} cm³ of gas per 100 g of water; and antimony is only very slightly soluble. Because solubility and availability have a positive correlation and the metals emitted will most likely be in the insoluble, inorganic form, a 10 percent absorption fraction was chosen as the default value for this screening assessment (Klassen et al., 1986).

Table 4-3-2a Acute Exposure Calculations for Indicator Species

Indicator Species	Body Wt. (Kg)	Contaminant of Concern	Total Dose of Soil				Total Dose of Vegetation				Total Dose of Contam. Ingested in Prey				ACUTE	
			Soil Conc. (mg/Kg)	Ingestion Rate (Kg/day)	Soil Ingestion (mg/day)	Contam. Ingested in (mg/day)	Vegetation Ingestion Rate (Kg/day)	Vegetation Conc. (mg/Kg)	Contam. Ingested in (mg/day)	Prey Ingestion Rate (Kg/day)	Contam. Ingested through Prey (mg/day)	Total Dose of Contam. Ingested (mg/day)	Total Dose of Contam. Ingested (mg/day)	Total Dose of Contam. Ingested (mg/day)	Body Wt.	
Earthworm	1.5E-03	Aluminum	6.81E+03	5.40E-05	3.68E-01	1.26E-04	1.26E-04	3.89E+02	4.90E-02	0.00E+00	0.00E+00	0.00E+00	1.13E-01	7.50E+01		
Robin	8.4E-02	Aluminum	6.81E+03	5.60E-05	3.81E-01	6.60E-03	6.60E-03	3.89E+02	2.57E+00	4.40E-03	4.95E-04	4.95E-04	7.96E-01	9.46E+00		
Mouse	3.0E-02	Aluminum	6.81E+03	7.80E-05	5.31E-01	1.95E-03	1.95E-03	3.89E+02	7.59E-01	1.95E-03	2.19E-04	2.19E-04	3.48E-01	1.16E+01		
Deer	3.0E+01	Aluminum	6.81E+03	1.36E-01	9.23E+02	2.26E+00	2.26E+00	3.89E+02	8.79E+02	0.00E+00	0.00E+00	0.00E+00	4.87E+02	1.62E+01		
Earthworm	1.5E-03	Antimony	8.15E+01	5.40E-05	4.40E-03	1.26E-04	1.26E-04	5.99E+00	7.55E-04	0.00E+00	0.00E+00	0.00E+00	3.61E-04	2.41E-01		
Robin	8.4E-02	Antimony	8.15E+01	5.60E-05	4.56E-03	6.60E-03	6.60E-03	5.99E+00	3.95E-02	4.40E-03	1.59E-06	1.59E-06	3.09E-03	3.67E-02		
Mouse	3.0E-02	Antimony	8.15E+01	7.80E-05	6.36E-03	1.95E-03	1.95E-03	5.99E+00	1.17E-02	1.95E-03	7.04E-07	7.04E-07	1.26E-03	4.21E-02		
Deer	3.0E+01	Antimony	8.15E+01	1.36E-01	1.11E+01	2.26E+00	2.26E+00	5.99E+00	1.35E+01	0.00E+00	0.00E+00	0.00E+00	1.72E+00	5.74E-02		
Earthworm	1.5E-03	Barium	7.29E+01	5.40E-05	3.94E-03	1.26E-04	1.26E-04	3.49E+02	4.40E-02	0.00E+00	0.00E+00	0.00E+00	4.79E-03	3.19E+00		
Robin	8.4E-02	Barium	7.29E+01	5.60E-05	4.08E-03	6.60E-03	6.60E-03	3.49E+02	2.30E+00	4.40E-03	2.11E-05	2.11E-05	2.31E-01	2.74E+00		
Mouse	3.0E-02	Barium	7.29E+01	7.80E-05	5.69E-03	1.95E-03	1.95E-03	3.49E+02	6.81E-01	1.95E-03	9.34E-06	9.34E-06	6.86E-02	2.29E+00		
Deer	3.0E+01	Barium	7.29E+01	1.36E-01	9.89E+00	2.26E+00	2.26E+00	3.49E+02	7.89E+02	0.00E+00	0.00E+00	0.00E+00	7.99E+01	2.66E+00		
Earthworm	1.5E-03	Beryllium	7.37E-01	5.40E-05	3.98E-05	1.26E-04	1.26E-04	5.22E-02	6.58E-06	0.00E+00	0.00E+00	0.00E+00	2.32E-06	1.55E-03		
Robin	8.4E-02	Beryllium	7.37E-01	5.60E-05	4.13E-05	6.60E-03	6.60E-03	5.22E-02	3.45E-04	4.40E-03	1.02E-08	1.02E-08	1.93E-05	2.29E-04		
Mouse	3.0E-02	Beryllium	7.37E-01	7.80E-05	5.75E-05	1.95E-03	1.95E-03	5.22E-02	1.02E-04	1.95E-03	4.52E-09	4.52E-09	7.96E-06	2.65E-04		
Deer	3.0E+01	Beryllium	7.37E-01	1.36E-01	9.99E-02	2.26E+00	2.26E+00	5.22E-02	1.18E-01	0.00E+00	0.00E+00	0.00E+00	1.09E-02	3.63E-04		
Earthworm	1.5E-03	Chromium	5.61E-01	5.40E-05	3.03E-05	1.26E-04	1.26E-04	3.65E-02	4.60E-06	0.00E+00	0.00E+00	0.00E+00	5.23E-07	3.49E-04		
Robin	8.4E-02	Chromium	5.61E-01	5.60E-05	3.14E-05	6.60E-03	6.60E-03	3.65E-02	2.41E-04	4.40E-03	2.30E-09	2.30E-09	4.08E-06	4.85E-05		
Mouse	3.0E-02	Chromium	5.61E-01	7.80E-05	4.38E-05	1.95E-03	1.95E-03	3.65E-02	7.12E-05	1.95E-03	1.02E-09	1.02E-09	1.72E-06	5.75E-05		
Deer	3.0E+01	Chromium	5.61E-01	1.36E-01	7.61E-02	2.26E+00	2.26E+00	3.65E-02	8.25E-02	0.00E+00	0.00E+00	0.00E+00	2.38E-03	7.93E-05		
Earthworm	1.5E-03	Copper	7.08E+00	5.40E-05	3.82E-04	1.26E-04	1.26E-04	6.68E+00	8.42E-04	0.00E+00	0.00E+00	0.00E+00	1.22E-04	8.16E-02		
Robin	8.4E-02	Copper	7.08E+00	5.60E-05	3.96E-04	6.60E-03	6.60E-03	6.68E+00	4.41E-02	4.40E-03	5.39E-07	5.39E-07	4.45E-03	5.28E-02		
Mouse	3.0E-02	Copper	7.08E+00	7.80E-05	5.59E-04	1.95E-03	1.95E-03	6.68E+00	1.30E-02	1.95E-03	2.39E-07	2.39E-07	1.36E-03	4.53E-02		
Deer	3.0E+01	Copper	7.08E+00	1.36E-01	9.60E-01	2.26E+00	2.26E+00	6.68E+00	1.51E+01	0.00E+00	0.00E+00	0.00E+00	1.61E+00	5.35E-02		

Table 4-3-2a Acute Exposure Calculations for Indicator Species (Con't)

Indicator Species	Body Wt. (Kg)	Contaminant of Concern	Soil Conc. (mg/Kg)	Total Dose of Contam.			Total Dose of Contam.			Total Dose of Contam.			ACUTE	
				Soil Ingestion Rate (Kg/day)	Ingested in Soil (mg/day)	Vegetation Ingestion Rate (Kg/day)	Vegetation Conc (mg/Kg)	Ingested in Vegetation (mg/day)	Prey Ingestion Rate (Kg/day)	Ingested through Prey (mg/day)	Total Dose of Contam. Ingested (mg/day)	Total Dose of Contam. Ingested per Body Wt. (mg/Kg/day)		
Earthworm	1.5E-03	Lead	7.58E+02	5.40E-05	4.09E-02	1.26E-04	5.02E+01	6.33E-03	0.00E+00	0.00E+00	4.73E-03	3.15E+00		
Robin	8.4E-02	Lead	7.58E+02	5.60E-05	4.24E-02	6.60E-03	5.02E+01	3.31E-01	4.40E-03	2.08E-05	3.74E-02	4.44E-01		
Mouse	3.0E-02	Lead	7.58E+02	7.80E-05	5.91E-02	1.95E-03	5.02E+01	9.79E-02	1.95E-03	9.22E-06	1.57E-02	5.23E-01		
Deer	3.0E+01	Lead	7.58E+02	1.36E-01	1.03E+02	2.26E+00	5.02E+01	1.13E+02	0.00E+00	0.00E+00	2.16E+01	7.21E-01		
Earthworm	1.5E-03	Mercury	0.00E+00	5.40E-05	0.00E+00	1.26E-04	1.55E-07	1.95E-11	0.00E+00	0.00E+00	1.95E-12	1.30E-09		
Robin	8.4E-02	Mercury	0.00E+00	5.60E-05	0.00E+00	6.60E-03	1.55E-07	1.02E-09	4.40E-03	8.59E-15	1.02E-10	1.21E-09		
Mouse	3.0E-02	Mercury	0.00E+00	7.80E-05	0.00E+00	1.95E-03	1.55E-07	3.02E-10	1.95E-03	3.81E-15	3.02E-11	1.01E-09		
Deer	3.0E+01	Mercury	0.00E+00	1.36E-01	0.00E+00	2.26E+00	1.55E-07	3.50E-07	0.00E+00	0.00E+00	3.50E-08	1.17E-09		
Earthworm	1.5E-03	Nickel	3.24E+01	5.40E-05	1.75E-03	1.26E-04	6.01E+00	7.57E-04	0.00E+00	0.00E+00	4.76E-05	3.18E-02		
Robin	8.4E-02	Nickel	3.24E+01	5.60E-05	1.81E-03	6.60E-03	6.01E+00	3.97E-02	4.40E-03	2.10E-07	7.88E-01	9.36E-03		
Mouse	3.0E-02	Nickel	3.24E+01	7.80E-05	2.53E-03	1.95E-03	6.01E+00	1.17E-02	1.95E-03	9.29E-08	2.71E-01	9.02E-03		
Deer	3.0E+01	Nickel	3.24E+01	1.36E-01	4.39E+00	2.26E+00	6.01E+00	1.36E+01	0.00E+00	0.00E+00	3.42E-01	1.14E-02		
Earthworm	1.5E-03	Selenium	2.73E+02	5.40E-05	1.47E-02	1.26E-04	1.59E+02	2.00E-02	0.00E+00	0.00E+00	3.48E-03	2.32E+00		
Robin	8.4E-02	Selenium	2.73E+02	5.60E-05	1.53E-02	6.60E-03	1.59E+02	1.05E+00	4.40E-03	1.53E-05	1.06E-01	1.26E+00		
Mouse	3.0E-02	Selenium	2.73E+02	7.80E-05	2.13E-02	1.95E-03	1.59E+02	3.10E-01	1.95E-03	6.78E-06	3.31E-02	1.10E+00		
Deer	3.0E+01	Selenium	2.73E+02	1.36E-01	3.70E+01	2.26E+00	1.59E+02	3.59E+02	0.00E+00	0.00E+00	3.96E+01	1.32E+00		
Earthworm	1.5E-03	Zinc	5.05E+01	5.40E-05	2.73E-03	1.26E-04	1.11E+01	1.40E-03	0.00E+00	0.00E+00	2.35E-04	1.57E-01		
Robin	8.4E-02	Zinc	5.05E+01	5.60E-05	2.83E-03	6.60E-03	1.11E+01	7.33E-02	4.40E-03	1.03E-06	4.34E-03	5.15E-02		
Mouse	3.0E-02	Zinc	5.05E+01	7.80E-05	3.94E-03	1.95E-03	1.11E+01	2.16E-02	1.95E-03	4.59E-07	1.46E-03	4.86E-02		
Deer	3.0E+01	Zinc	5.05E+01	1.36E-01	6.85E+00	2.26E+00	1.11E+01	2.51E+01	0.00E+00	0.00E+00	1.82E+00	6.07E-02		

Table 4-3-2b *Chronic Exposure Calculations for Indicator Species*

Indicator Species	Body Wt. (Kg)	Contaminant of Concern	Soil Conc. (mg/Kg)	Total Dose of			Total Dose of			CHRONIC	
				Soil Ingestion Rate (Kg/day)	Vegetation Ingestion Rate (Kg/day)	Vegetation Conc. (mg/Kg)	Contam. Ingested in Vegetation (mg/day)	Prey Ingestion Rate (Kg/day)	Total Dose of Ingested through Prey (mg/day)	Total Dose of Contam. Ingested (mg/day)	Total Dose Ingested per Body Wt. (mg/Kg/day)
Earthworm	1.5E-03	Aluminum	6.81E+03	5.40E-05	1.26E-04	3.89E+02	4.90E-02	0.00E+00	0.00E+00	1.13E-01	7.50E+01
Robin	8.4E-02	Aluminum	6.81E+03	5.60E-05	6.60E-03	3.89E+02	2.57E+00	4.40E-03	4.95E-04	3.98E-01	4.73E+00
Mouse	3.0E-02	Aluminum	6.81E+03	7.80E-05	1.95E-03	3.89E+02	7.59E-01	1.95E-03	2.19E-04	2.61E-01	8.71E+00
Deer	3.0E+01	Aluminum	6.81E+03	1.36E-01	2.26E+00	3.89E+02	8.79E+02	0.00E+00	0.00E+00	2.43E+02	8.11E+00
Earthworm	1.5E-03	Antimony	8.15E+01	5.40E-05	1.26E-04	5.99E+00	7.55E-04	0.00E+00	0.00E+00	3.61E-04	2.41E-01
Robin	8.4E-02	Antimony	8.15E+01	5.60E-05	6.60E-03	5.99E+00	3.95E-02	4.40E-03	1.59E-06	1.54E-03	1.83E-02
Mouse	3.0E-02	Antimony	8.15E+01	7.80E-05	1.95E-03	5.99E+00	1.17E-02	1.95E-03	7.04E-07	9.47E-04	3.16E-02
Deer	3.0E+01	Antimony	8.15E+01	1.36E-01	2.26E+00	5.99E+00	1.35E+01	0.00E+00	0.00E+00	8.61E-01	2.87E-02
Earthworm	1.5E-03	Barium	7.29E+01	5.40E-05	1.26E-04	3.19E+02	4.10E-02	0.00E+00	0.00E+00	4.79E-03	3.19E+00
Robin	8.4E-02	Barium	7.29E+01	5.60E-05	6.60E-03	3.19E+02	2.30E+00	4.40E-03	2.11E-05	1.15E-01	1.37E+00
Mouse	3.0E-02	Barium	7.29E+01	7.80E-05	1.95E-03	3.19E+02	6.81E-01	1.95E-03	9.34E-06	5.15E-02	1.72E+00
Deer	3.0E+01	Barium	7.29E+01	1.36E-01	2.26E+00	3.19E+02	7.89E+02	0.00E+00	0.00E+00	3.99E+01	1.33E+00
Earthworm	1.5E-03	Beryllium	7.37E-01	5.40E-05	1.26E-04	5.27E+02	6.58E-06	0.00E+00	0.00E+00	2.32E-06	1.55E-03
Robin	8.4E-02	Beryllium	7.37E-01	5.60E-05	6.60E-03	5.27E+02	3.15E-04	4.40E-03	1.02E-08	9.65E-06	1.15E-04
Mouse	3.0E-02	Beryllium	7.37E-01	7.80E-05	1.95E-03	5.27E+02	1.02E-04	1.95E-03	4.52E-09	5.97E-06	1.99E-04
Deer	3.0E+01	Beryllium	7.37E-01	1.36E-01	2.26E+00	5.27E+02	1.18E-01	0.00E+00	0.00E+00	5.45E-03	1.82E-04
Earthworm	1.5E-03	Chromium	5.61E-01	5.40E-05	1.26E-04	3.65E+02	4.60E-06	0.00E+00	0.00E+00	5.23E-07	3.49E-04
Robin	8.4E-02	Chromium	5.61E-01	5.60E-05	6.60E-03	3.65E+02	2.41E-04	4.40E-03	2.30E-09	2.04E-06	2.43E-05
Mouse	3.0E-02	Chromium	5.61E-01	7.80E-05	1.95E-03	3.65E+02	7.12E-05	1.95E-03	1.02E-09	1.29E-06	4.31E-05
Deer	3.0E+01	Chromium	5.61E-01	1.36E-01	2.26E+00	3.65E+02	8.25E-02	0.00E+00	0.00E+00	1.19E-03	3.96E-05
Earthworm	1.5E-03	Copper	7.08E+00	5.40E-05	1.26E-04	6.68E+00	8.42E-04	0.00E+00	0.00E+00	1.22E-04	8.16E-02
Robin	8.4E-02	Copper	7.08E+00	5.60E-05	6.60E-03	6.68E+00	4.41E-02	4.40E-03	5.39E-07	2.22E-03	2.64E-02
Mouse	3.0E-02	Copper	7.08E+00	7.80E-05	1.95E-03	6.68E+00	1.30E-02	1.95E-03	2.39E-07	1.02E-03	3.39E-02
Deer	3.0E+01	Copper	7.08E+00	1.36E-01	2.26E+00	6.68E+00	1.51E+01	0.00E+00	0.00E+00	8.03E-01	2.68E-02

Table 4-3-2b Chronic Exposure Calculations for Indicator Species (Con't)

Indicator Species	Body Wt. (Kg)	Contaminant of Concern	Soil Conc. (mg/Kg)	Total Dose of Contam.			Total Dose of Contam. Ingested in Vegetation			Total Dose of Contam. Ingested in Prey			Total Dose of Contam. Ingested per Body Wt.	
				Soil Ingestion Rate (Kg/day)	Soil Ingested (mg/day)	Vegetation Ingestion Rate (Kg/day)	Vegetation Conc. (mg/Kg)	Vegetation Ingested (mg/day)	Vegetation Ingestion Rate (Kg/day)	Prey Ingestion Rate (Kg/day)	Prey Ingested (mg/day)	Total Dose of Contam. Ingested (mg/day)	Total Dose of Contam. Ingested per Body Wt. (mg/Kg/day)	CHRONIC
Earthworm	1.5E-03	Lead	7.58E+02	5.40E-05	4.09E+02	1.26E-04	5.02E+01	6.33E-03	0.00E+00	0.00E+00	0.00E+00	4.73E-03	3.15E+00	
Robin	8.4E-02	Lead	7.58E+02	5.60E-05	4.24E+02	6.60E-03	5.02E+01	3.31E-01	4.40E-03	4.40E-03	2.08E-05	1.87E-02	2.22E-01	
Mouse	3.0E-02	Lead	7.58E+02	7.80E-05	5.91E+02	1.95E-03	5.02E+01	9.79E-02	1.95E-03	1.95E-03	9.22E-06	1.18E-02	3.93E-01	
Deer	3.0E+01	Lead	7.58E+02	1.36E-01	1.03E+02	2.26E+00	5.02E+01	1.13E+02	0.00E+00	0.00E+00	0.00E+00	1.08E+01	3.60E-01	
Earthworm	1.5E-03	Mercury	0.00E+00	5.40E-05	0.00E+00	1.26E-04	1.55E-07	1.95E-11	0.00E+00	0.00E+00	0.00E+00	1.95E-12	1.30E-09	
Robin	8.4E-02	Mercury	0.00E+00	5.60E-05	0.00E+00	6.60E-03	1.55E-07	1.02E-09	4.40E-03	4.40E-03	8.59E-15	5.12E-11	6.07E-10	
Mouse	3.0E-02	Mercury	0.00E+00	7.80E-05	0.00E+00	1.95E-03	1.55E-07	3.02E-10	1.95E-03	1.95E-03	3.81E-15	2.27E-11	7.56E-10	
Deer	3.0E+01	Mercury	0.00E+00	1.36E-01	0.00E+00	2.26E+00	1.55E-07	3.50E-07	0.00E+00	0.00E+00	0.00E+00	1.75E-08	5.84E-10	
Earthworm	1.5E-03	Nickel	3.24E+01	5.40E-05	1.25E+03	1.26E-04	6.01E+00	7.57E-04	0.00E+00	0.00E+00	0.00E+00	4.76E-05	3.18E-02	
Robin	8.4E-02	Nickel	3.24E+01	5.60E-05	1.81E+03	6.60E-03	6.01E+00	3.97E-02	4.40E-03	4.40E-03	2.10E-07	3.94E-04	4.68E-03	
Mouse	3.0E-02	Nickel	3.24E+01	7.80E-05	2.53E+03	1.95E-03	6.01E+00	1.17E-02	1.95E-03	1.95E-03	9.29E-08	2.03E-04	6.77E-03	
Deer	3.0E+01	Nickel	3.24E+01	1.36E-01	4.39E+00	2.26E+00	6.01E+00	1.36E+01	0.00E+00	0.00E+00	0.00E+00	1.71E-01	5.69E-03	
Earthworm	1.5E-03	Selenium	2.73E+02	5.40E-05	1.47E+02	1.26E-04	1.59E+02	2.00E-02	0.00E+00	0.00E+00	0.00E+00	3.48E-03	2.32E+00	
Robin	8.4E-02	Selenium	2.73E+02	5.60E-05	1.53E+02	6.60E-03	1.59E+02	1.05E+00	4.40E-03	4.40E-03	1.53E-05	5.32E-02	6.32E-01	
Mouse	3.0E-02	Selenium	2.73E+02	7.80E-05	2.13E+02	1.95E-03	1.59E+02	3.10E-01	1.95E-03	1.95E-03	6.78E-06	2.49E-02	8.28E-01	
Deer	3.0E+01	Selenium	2.73E+02	1.36E-01	3.70E+01	2.26E+00	1.59E+02	3.59E+02	0.00E+00	0.00E+00	0.00E+00	1.98E+01	6.61E-01	
Earthworm	1.5E-03	Zinc	5.05E+01	5.40E-05	2.73E+03	1.26E-04	1.11E+01	1.40E-03	0.00E+00	0.00E+00	0.00E+00	2.35E-04	1.57E-01	
Robin	8.4E-02	Zinc	5.05E+01	5.60E-05	2.83E+03	6.60E-03	1.11E+01	7.33E-02	4.40E-03	4.40E-03	1.03E-06	2.17E-03	2.58E-02	
Mouse	3.0E-02	Zinc	5.05E+01	7.80E-05	3.94E+03	1.95E-03	1.11E+01	2.16E-02	1.95E-03	1.95E-03	4.59E-07	1.09E-03	3.65E-02	
Deer	3.0E+01	Zinc	5.05E+01	1.36E-01	6.85E+00	2.26E+00	1.11E+01	2.51E+01	0.00E+00	0.00E+00	0.00E+00	9.10E-01	3.03E-02	

Maximum values were utilized for ingestion and concentration parameters. For example Edwards and Lofty (1972) provided a range of 20 - 30 percent of body weight for soil ingestion for the earthworm; thus, the assumption was made that 30 percent of an earthworms body weight was due to soil ingestion. For the robin and mouse scenarios, it was conservatively assumed that all prey were earthworms. The vegetation concentration represented the concentration of metals found in forage, except mercury, since these concentrations were higher than the metal concentrations found in fruits and leafy vegetables. Mercury concentrations were higher in fruits and leafy vegetables, therefore, the concentration of fruits and leafy vegetables was used for mercury when calculating vegetation ingestion. Therefore, it was conservatively assumed that all of the indicator species would be ingesting forage type vegetation for all of the metals, except mercury.

4.4 RISK CHARACTERIZATION

4.4.1 RISK EVALUATION

Risk evaluation or characterization consist of comparing maximum estimated daily intake doses against known ecological effects criteria (NOAELs). To provide a means of comparison, a chronic quotient was calculated by dividing the NOAEL value by the total intake dose. Likewise, an acute quotient was calculated by dividing an LD₅₀ by the total intake dose. The derived values are termed a chronic and acute hazard quotient (HQ), respectively. A HQ greater than one indicates a degree of ecological risk. As a guideline for interpretation USEPA (1989) assumes that a quotient between 1 and 10 indicates possible ecological risk and a HQ greater than 10 indicates a probable ecological risk.

Table 4-3-1 present the calculated HQs for each indicator species at the property fence line.

4.4.2 Risk Characterization of Individual Metals

Nine out of the eleven metals had chronic and acute HQs less than one. These metals were aluminum, antimony, beryllium, chromium, copper, lead, mercury, nickel, and zinc. Therefore, these nine metals noted above were assumed to not be of concern from an ecological standpoint.

The remaining two metals listed below have chronic HQs greater than one:

Metal	Species	Chronic HQ
Barium	Mouse	1.8
	Deer	24.6
Selenium	Robin	1.26
	Mouse	2.43
	Deer	2.2

The acute and chronic HQs shown above represent an estimate using multiple conservative assumptions regarding exposure, absorption, ingestion rates and toxicological data. Due to the limited toxicological data available for ecological species there are data gaps. For example no LD₅₀ values could be found for antimony and therefore an acute HQ was not calculated. The absence of chronic and acute earthworm toxicological data also represents a data gap. Absorption rates were not available for barium, copper, lead, and selenium; therefore, ERM assumed that 10 percent of the metal would be absorbed. A discussion of estimated risk for each of the above two metals is presented below.

Barium

The chronic HQs for barium estimated a possible risk to small mammals and deer. Studies have indicated that barium is poorly absorbed in the digestive tract of adult animals, but may be more readily absorbed in juveniles (ATSDR, 1990b). However, no absorption factors for species tested were available in the literature. In addition to the uncertainty with regard to absorption, many of the other conservative assumptions used for this worst-case assessment may over-estimate actual risk to the indicator species. Thus, the HQ values may over-estimate the risk due to barium ingestion.

Selenium

Chronic HQs for selenium indicate a possible risk to small mammals and birds. However, because the calculated chronic HQ values are at the low end of USEPA's possible risk range and many conservative assumptions were used in this worst-case assessment, it is expected that actual risks due to selenium ingestion will be low.

4.4.3

Uncertainty Factors

There are a number of difficulties involved in the prediction of ecological risk. A major source of uncertainty is the extrapolation of laboratory derived data to the natural environment. Many factors that will influence a toxicological response are encountered in the real world which can not

be predicted in the laboratory. Uncertainty is also introduced when one attempts to assess low-exposure risk in a multi-factor situation. Often it is not possible to identify the causative agents, and dose-response parameters are thus difficult to characterize. Synergistic or antagonistic interactions complicate risk extrapolation procedures. Antagonistic interactions are more commonly encountered with metals. For example, iron may reverse the harmful affects of lead. The intake of zinc also inhibits the gastrointestinal absorption of lead. The following summarizes the uncertainty factors involved with this risk assessment.

- Exposure calculations assumed that metals in the soils would be 100 percent bioavailable. Based on the major fate process of aluminum, antimony, beryllium, chromium, copper, lead, nickel, selenium, and zinc, these metals will strongly absorb to organic matter in soils, sediments, and suspended particles, and thus are not expected to be 100 percent bioavailable to wildlife. However, the mobility and bioavailability of these metals in soils is increased with decreasing soil pH. According to the Soil Survey of Grant Parish, the soils within the property and surrounding area have a pH range of 4.5 - 5.1.
- Exposure calculations also assumed that metals in vegetation and prey would be 100 percent bioavailable. However, because of the metals' low absorption fractions due to insolubility, 100 percent bioavailability is a likely overestimation of biotransfer and subsequent availability.
- General absorption rates found in the literature for aluminum, antimony, beryllium, chromium, nickel, and zinc were used for the exposure calculations to determine the amount of metals that would be absorbed into the gastrointestinal system when ingested by the indicator species. Uncertainty exists with the use of these absorption rates, since absorption rates have only been determined for a few laboratory animals and are highly dependent on the age of an animal and the species of animal. Absorption rates for the remainder of the metals were not available; therefore, 10 percent absorption was assumed for these metals. Because metals will probably be released in the insoluble form, a 10 percent absorption fraction may lead to an over-estimation of ecological risk.
- The use of toxicity data of mice and rats to extrapolate effects to other species poses a large uncertainty. The metabolic degradation rates and many other physiological processes of a mouse will not be the same for other species.
- Model soil concentrations for barium, beryllium, chromium, copper, nickel, and zinc are less than background soil concentrations. As discussed in Section 3.4, if soil concentrations resulting from facility

operations do not exceed background concentrations, facility operations should not pose a risk to ecological populations.

- The exposure calculation assumed that the animal portion of the diets of robins and mice would consist 100 percent of earthworms. A percent breakdown of the contents of animal diets of robins and mice were not available in the literature to more realistically evaluate the exposure.
- The dispersion model assumed no boundary layer. The presence of mature trees over the majority of the property and surrounding area will likely reduce the amount of deposition due to interception. Therefore, soil concentrations at the property boundary will likely be less than predicted.
- This ERA made many conservative assumptions which result in a worst case screening. Wild populations of animals are not likely to receive maximum exposure because they are free to roam and inhabit areas more suitable to their needs. Exposure to worst case conditions will likely be intermittent.

4.4.4

Ecological Risk Summary

The screening ecological risk assessment estimated a possible risk due to barium and selenium. Because modeled barium soil concentrations resulting from facility operations do not exceed background concentrations, facility operations should not pose a risk to ecological populations with regard to barium. Although selenium soil concentrations resulting from facility operations are predicted to exceed background levels, the form of selenium (SeO_3) deposited is expected to be insoluble, thus leading to limited bioavailability. Based on a preliminary assessment of the availability of insoluble selenium, selenium is not expected to pose a potential risk to the terrestrial ecosystem.

This ERA assumed worst case assumptions which may over-estimate the actual risk. Actual risk is influenced by many physical, chemical and biological factors encountered in the environment. Bioavailability of the element will be dependent on such factors as chemical species present, soil acidity, organic content of the soils and synergism and antagonism of other elements. Ecological species will exhibit species-specific rates of absorption, bioaccumulation, metabolism and sensitivity to toxicological properties.

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